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Final

# Work Plan for Site Inspection at Site UXO-08 Bazooka Range and Gas Chambers

## Marine Corps Base Camp Lejeune Jacksonville, North Carolina

NAVFAC
Naval Facilities Engineering Command
NAVFAC ATLANTIC

Prepared for

## Department of the Navy

Naval Facilities Engineering Command
Atlantic Division

Under the

NAVFAC CLEAN III Program
Contract No. N62470-02-D-3052
CTO-0109

October 2006

Prepared by

CH2MHILL

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**Herndon, Virginia**

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# Acronyms and Abbreviations

| | |
|---|---|
| °F | degrees Fahrenheit |
| AM | Activity Manager |
| ARAR | applicable or relevant and appropriate requirement |
| bgs | below ground surface |
| BTEX | benzene, toluene, ethylbenzene, and total xylenes |
| CAMA | Coastal Area Management Act |
| CAP | corrective action plan |
| CAR | Corrective Action Request |
| CFR | Code of Federal Regulations |
| CIH | Certified Industrial Hygienist |
| CLEAN | Comprehensive Long-Term Environmental Action Navy |
| CLP | contract laboratory program |
| COC | chain-of-custody |
| CSP | Certified Safety Profession |
| CTO | contract task order |
| DCE | dichloroethene |
| DENR | Department of Environment and Natural Resources |
| DFOW | definable feature of work |
| DGM | digital geophysical mapping |
| DGPS | differential global positioning system |
| DPT | direct push technology |
| DQO | data quality objective |
| EIS | Environmental Information Specialist |
| EOD | Explosive Ordnance Disposal |
| EPA | U.S. Environmental Protection Agency |
| ESS | Explosives Safety Submission |
| FTL | Field Team Leader |
| GIP | Geophysical Investigation Plan |
| GIS | geographical information system |
| GPO | geophysical prove-out |
| GPS | global positioning system |
| HSM | Health and Safety Manager |
| HSP | Health and Safety Plan |
| HTW | hazardous and toxic waste |
| IDW | investigation-derived waste |
| MC | munitions constituents |
| MCB | Marine Corps Base |

| | |
|---|---|
| MEC | munitions and explosives of concern |
| MILCON | ***Military Construction*** |
| MPPEH | material potentially presenting an explosive hazard |
| MR | munitions response |
| MRP | Munitions Response Program |
| MRSIMS | Munitions Response Site Information Management System |
| msl | mean sea level |
| MS/MSD | matrix spike/matrix spike duplicate |
| NAVFAC | Naval Facilities Engineering Command |
| NBC | Nuclear, Biological, and Chemical |
| OU | operable unit |
| PAH | polycyclic aromatic hydrocarbons |
| PARCC | precision, accuracy, representativeness, comparability, and completeness |
| PC | project chemist |
| PCB | polychlorinated biphenyl |
| PM | Project Manager |
| ppb | parts per billion |
| PQL | practical quantification limit |
| QACM | Quality Assurance Control Manager |
| QA/QC | quality assurance/quality control |
| QC | quality control |
| QCP | Quality Control Plan |
| RI | remedial investigation |
| RPD | relative percent difference |
| RTK | real-time kinematic |
| SI | site inspection |
| SCS | Soil Conservation Service |
| SOP | standard operating procedure |
| SSC | Site Safety Coordinator |
| SVOC | semivolatile organic compound |
| TAL | target analyte list |
| TCE | tricholorethene |
| TCL | target compound list |
| TOC | total organic carbon |
| TPH | total petroleum hydrocarbons |
| USA | USA Environmental |
| USACE | U.S. Army Corps of Engineers |
| USCS | Unified Soil Classification System |
| USFWS | U.S. Fish and Wildlife Service |
| UXO | unexploded ordnance |
| UXOQCS | UXO QC Specialist |
| VOC | volatile organic compound |

SECTION 1

# Introduction

CH2M HILL is conducting a Site Inspection (SI) at Marine Corps Base (MCB) Camp Lejeune Site UXO-08. The SI is being conducted for the Department of the Navy, Naval Facilities Engineering Command (NAVFAC), under the Comprehensive Long-Term Environmental Action Navy (CLEAN) III Program. This work is being performed under Modifications 02 and 03 to Contract Task Order 109 (CTO-109) of Contract No. N62470-02-D-3052.

The purpose of the SI is to evaluate the potential presence of munitions and explosives of concern (MEC) and hazardous and toxic waste (HTW) at Munitions Response Program (MRP) Site UXO-08.

## 1.1 Background and Project Objectives

Site UXO-08 is comprised of three areas as identified in the 2002 Draft Marine Corps Base Camp Lejeune Range Inventory Report (URS, 2002):

- Suspected former Lejeune Cantonment Area Bazooka Range
- D-7 Gas Chamber
- Base CS Chamber and Nuclear, Biological, and Chemical (NBC) Trail

A proposed 15-acre construction area is also located within Site UXO-08.

Due to historical activities within the project area (refer to Section 1.3), an SI is being conducted to accomplish the following objectives:

1. Identify historical activities at the project area that may have resulted in environmental contamination with MEC at Site UXO-08
2. Identify the presence and nature of any HTW contamination that may exist in the proposed 15-acre construction area
3. Determine the presence or absence of munitions constituents (MC) in surface soil at Site UXO-08
4. Evaluate the number and density of anomalies that could potentially represent subsurface MEC, and provide geophysical data for future MEC intrusive investigations, by conducting digital geophysical mapping (DGM) in grids located across Site UXO-08.

With the exception of MC, HTW contamination outside of the military construction (MILCON) area will not be addressed by this SI because of ongoing environmental investigations at other sites that overlap with Site UXO-08.

A separate work plan is being prepared for the planned geophysical survey and construction support within the 15-acre MILCON project footprint.

## 1.2 Work Plan Scope and Organization

This SI work plan provides background information needed to understand the project tasks, describes conditions at the site, and presents the technical approach to be used for implementation of the work activities. The following primary SI activities will be performed to accomplish the objectives described in Section 1.1:

- Conduct an archival records search to interview current and former installation personnel;
- Conduct a field investigation for HTW contamination by sampling existing groundwater monitoring wells and sampling soils within the 15-acre proposed MILCON construction project area;
- Collect surface soil samples across Site UXO-08 and analyze the samples for MC;
- Evaluate the number and density of anomalies that could potentially represent subsurface MEC, and provide geophysical data for future MEC intrusive investigations, by conducting DGM across portions of Site UXO-08; and
- Prepare an SI Report.

This work plan is divided into sections providing information on the detailed approach, including procedures to be employed during the execution of the project. Appendices to the work plan provide supporting documentation that details specific procedures for the execution of the project.

This work plan is organized as follows:

- **Section 1, Introduction**, provides general information about this work plan, describes the Parade Ground Area, summarizes the history of the site, and presents the project scope and objectives.
- **Section 2, Technical Management Plan**, identifies the technical approach, methods, and operational procedures that will be used to execute the SI project.
- **Section 3, Field Investigation Plan**, identifies the technical approach, methods, and operational procedures that will be used to execute the field investigation activities, including mobilization and demobilization, land surveying, sampling of environmental media, and DGM.
- **Section 4, Quality Control Plan (QCP)**, provides details of the approach, methods, and operational procedures to be employed for quality control (QC) of the SI at Site UXO-08.
- **Section 5, Environmental Protection Plan**, describes the approach, methods, and operational procedures to be employed to protect the natural environment during the performance of all tasks at Site UXO-08.
- **Section 6, References,** lists the references cited in the preceding sections.
- **Appendix A, Archival Records Research Report,** presents the results of the records search and personnel interviews that were conducted to identify historical activities that

may have resulted in environmental contamination of the project area with MEC or HTW. Appendix A also includes historical photographs obtained for this SI.

- **Appendix B, Health and Safety Plan (HSP)**, provides an interface with CH2M HILL's overall health and safety program and with the MCB Camp Lejeune Master Health and Safety Plan (CH2M HILL, August 2005). The HSP also includes the MEC avoidance procedures that will be used to ensure that onsite personnel are protected from MEC that may be present at the site
- **Appendix C, Geophysical Investigation Plan (GIP)**, details the approach, methods, and operational procedures that will be used in performing geophysical investigations at the site. The Geophysical Prove-Out (GPO) Plan is provided as an attachment to the GIP.
- **Appendix D, Standard Operating Procedures,** provides detailed procedures for conducting field sampling activities.

## 1.3 Site Location and Description

MCB Camp Lejeune is located on the Atlantic coast in Jacksonville, North Carolina (refer to Figure 1-1). The city of Jacksonville in Onslow County is the principal support community for the base. MCB Camp Lejeune occupies 156,000 acres and includes 11 miles of beach capable of supporting amphibious operations, 98 maneuver areas, 34 gun positions, 50 tactical landing zones, and 78 live fire ranges (MCB Camp Lejeune website, 2006).

Originally established in 1941, the base is home to Marine Expeditionary Force units and includes six major Marine Corps commands, two Navy commands, one Coast Guard command, and is home to several Marine Corps Formal schools. MCB Camp Lejeune supports a total population of approximately 138,000 people, to include 37,221 active duty military and 53,614 military dependents. In addition, the base employs 4,883 civilian employees and supports 42,562 military retirees and their dependents located in the region (Global Security Website, July 2005). The base is bisected by the New River, which flows southeasterly and forms a large estuary before entering the Atlantic Ocean. The Atlantic Ocean forms the southeastern boundary of the facility. The western and northwestern boundaries are U.S. Route 17 and North Carolina State Route 24, respectively. The city of Jacksonville is located immediately northwest of MCB Camp Lejeune.

Most of the land surrounding the facility is used for agriculture. Estuaries along the coast support commercial fishing. Residential resort areas are located adjacent to MCB Camp Lejeune along the Atlantic Ocean.

Site UXO-08 is situated in the east central portion of the base, as shown on Figure 1-1. The site is located in the Hadnot Point area of the base and is bounded by Holcomb Boulevard to the northwest, McHugh Boulevard to the southwest, Louis Road to the southeast, and Gum Street on the northeast, as shown on Figure 1-2.

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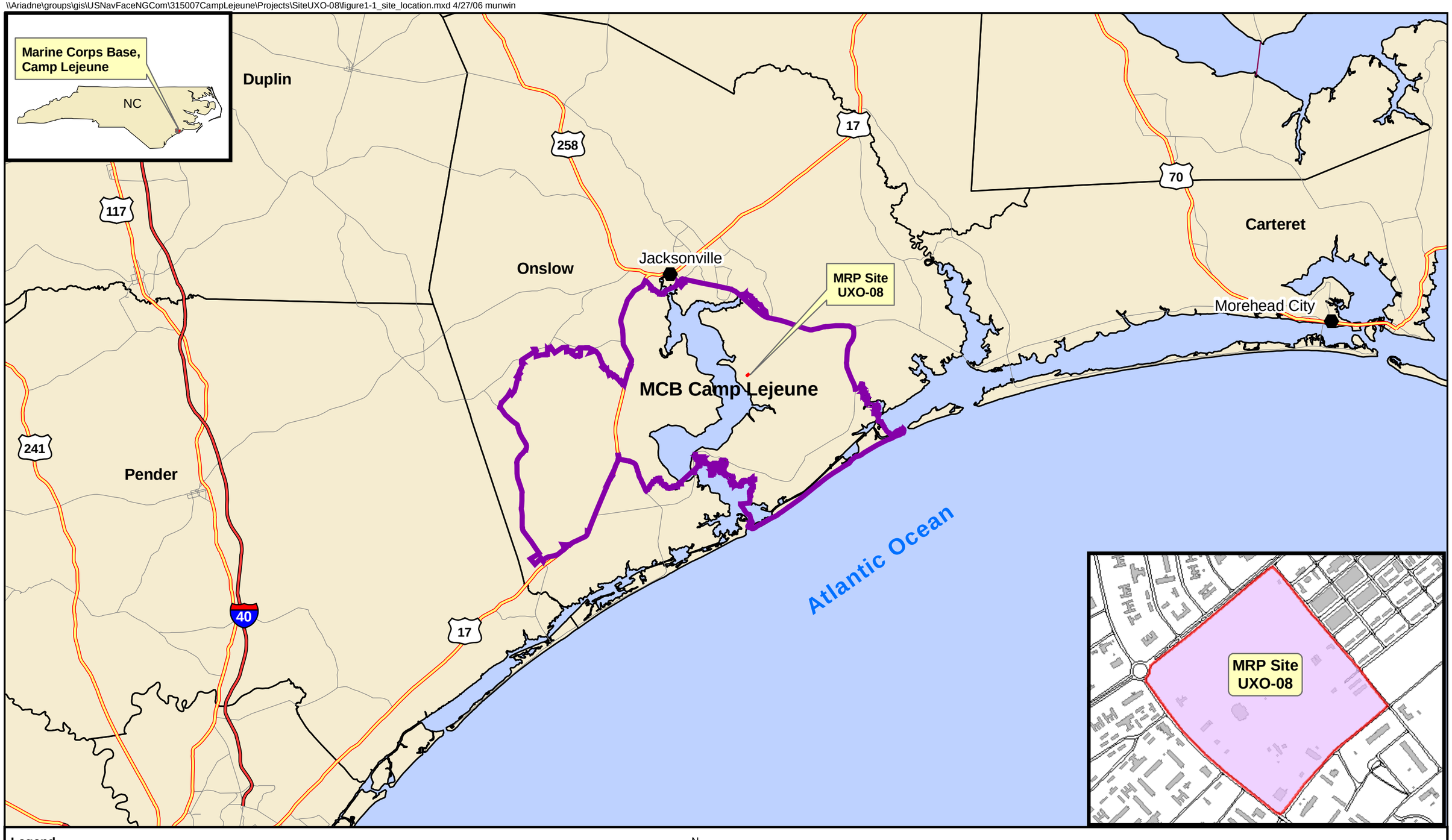


**Legend**
- Military Installation Area
- PA/SI Work Area (Parade Ground Area)
- Highway
- Limited Access Higwhay
- Local Roads
- Cities

N
W E
S

0 7 14
Kilometers

Figure 1-1
Site UXO-08 Location Map
Camp Lejeune, North Carolina

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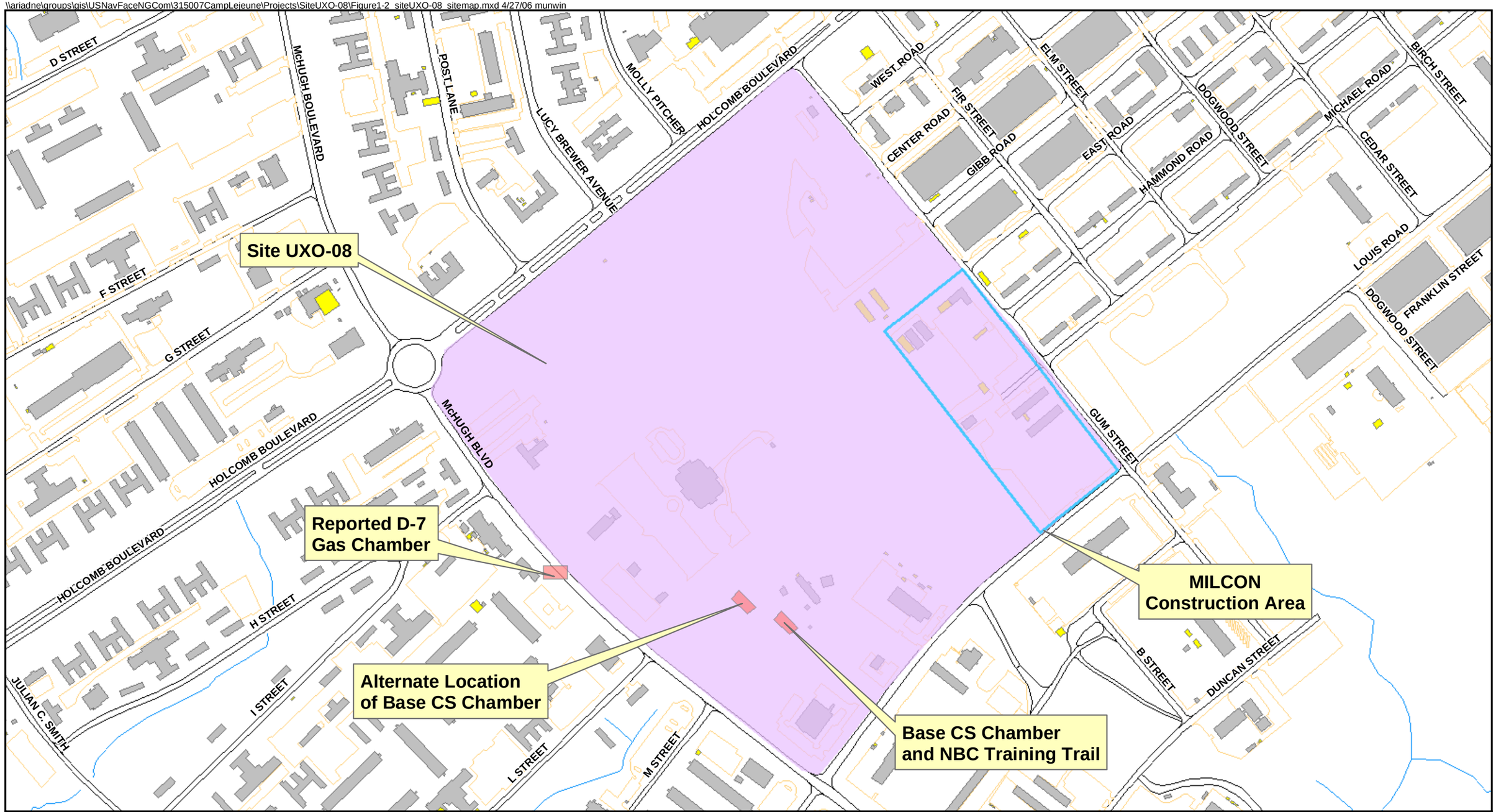


**Legend**

- PA/SI Work Area (Parade Ground Area)
- MILCON Construction Area
- Gas Chambers
- Buildings
- Vehicle Parking Area
- Road Area

N
W E
S

0 110 220
Meters

Figure 1-2
Site UXO-08 Site Map
Camp Lejeune, North Carolina

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The existing Parade Grounds, officially designated as W.P.T. Hill Field, are located within Site UXO-08 along the southeastern side of Holcomb Boulevard. The Parade Grounds are an expansive lawn used for ceremonies, receptions, parades, and other formal assemblies. It also hosts community gatherings, open-air concerts, including those by Camp Lejeune's 2d Marine Division Band, and athletic activities. W.P.T. Hill Field frequently serves as a helicopter landing zone for both administrative and tactical helicopter lifts (Camp Lejeune website, 2005). The Parade Grounds are surrounded on all four sides by industrial and administrative areas of the base.

The primary land use within Site UXO-08 consists of industrial and administrative areas. The eastern and northeastern portions of the site are primarily industrial and include the coal power plant and coal yard, while areas to the west and south-west are primarily administrative in nature.

The topography of the site is flat and the majority of Site UXO-08 has been cleared of trees, though some forested areas remain in the eastern third of the property. The site is approximately 144 acres in size, of which the MILCON project footprint comprises approximately 15 acres (refer to Figure 1-2).

## 1.4 Site History

Land planning for the Hadnot Point area began in late April 1941. The area was to contain the permanent administrative, housing, and subsistence buildings for the 1stMarDiv and was purchased under the name Area D (Louis Berger Group, 2002). W.P.T. Hill Field appears to have been originally located across approximately ten tracts of various sizes (John Jordan, 2005). At the time of purchase in November 1941 and September 1942, the land tracts contained structures such as school, cabins, cribs, smokehouses, stables, and barns (Department of the Navy, November 1941, September 1942). The facility at that time was known as Marine Barracks New River, N.C. and was changed to MCB Camp Lejeune in 1942 (Global Security website, July 19, 2005).

In March and April 1943, athletic fields were constructed on the land that now makes up Site UXO-08. The athletic fields were located on the eastern side of Holcomb Boulevard, opposite the Post Administration Building, and encompassed a parade ground, four base-ball diamonds, and a football stadium with a quarter mile track around it. The boundaries then were the same as they are now, with the area being bounded by Holcomb Boulevard on the west, Gum Street on the north, McHugh Boulevard on the south, and Louis Road on the east.

A 1943 map of the area shows the football field, baseball diamonds and eight other buildings, including the base heating plant (refer to Attachment 2 of Appendix A). To the north was the supply and industrial area, extending from Gum Street to Ash Street. Railroad tracks that brought coal to the heating plant ran through the length of the industrial area. On the western side of Holcomb Boulevard, from Molly Pitcher Drive to Main Service Road (now named McHugh Boulevard) was the Women’s Reserve area, an administrative area that included the Post Headquarters. Regimental Areas 1-5 were located south of McHugh

Boulevard. Historical photographs depict the area as it looked in 1944 and 1948 (see Photographs 1 and 2 in Attachment 2 to Appendix A).

A 1954 map of historical features shows the area largely unchanged except for some additional buildings. Of note are the addition of the Field House (Building 751), used for recreational purposes and the Base CS Chamber and NBC Trail. The location of the chamber and trail are shown on Figure 1-2. The CS Chamber was located about 200 meters east of the Field House and was used to simulate chemical exposure scenarios. The NBC Trail shows the decontamination procedures soldiers were required to conduct before they could leave the facility. The Base CS Chamber and the NBC Trail were also documented in the Range Identification and Preliminary Assessment Report (U.S. Army Corps of Engineers [USACE], 2001), which listed the following agents, chemical agent simulants, and munitions as having reportedly been used at this location:

- CS (O-Chlorobenzylidenemalononitrile, a non-lethal riot control agent)
- Simulants Chemical Agent PEG 200 (polyethylene glycol)
- Training Set, Chemical Agent Identification, Simulants M72A1/A2
- Blister Agent Simulant, Molasses Residuum
- Training Ammunitions (i.e., tear gas grenades, etc.)
- Atomic Explosion Simulator DVC 39-1
- Atomic Simulator (fabricated locally in accordance with FM 30-101)
- Artillery Simulator, M110.

No information is available to provide an estimated quantity of usage. The facility is estimated to have been in use from 1985 to 1987 (USACE, 2001; Duane Richardson, 2005).

A 1964 map shows that the recreational areas remained along with the parade ground. Additional industrial buildings on the northern end of the field and in the vicinity of the Base CS Chamber are also visible on the map.

The Range Identification and Preliminary Assessment Report (USACE, 2001) identified a second gas chamber in the site area: the D7 Gas Chamber located at Building 756. The gas chamber is estimated to have been in use from 1953 to 1961 and only tear gas was reported to have been used (USACE, 2001). Historical maps present a discrepancy in the actual location of the D7 Gas Chamber and NBC Trail; therefore, both locations (i.e., Base CS Chamber and Alternate Location of Base CS Chamber are shown on Figure 1-2.

The 2002 Range Inventory Report (URS Corp., 2002) reiterates previous findings of the presence of a tear-gas gas chamber and mentions the D-7 gas chamber, but does not verify the former location. In addition, the report indicates the presence of a suspected firing range, designated as the Lejeune Cantonment 2.36-in. Bazooka Range, in the main cantonment area, along with the D7 gas chamber.

As described in the ASR, former Explosive Ordnance Disposal (EOD) personnel reported historical EOD responses to inert practice 2.36-inch bazooka rounds in the 1970s and 1990s in the vicinity of Parade Grounds. In June 2006, a site visit was conducted with a former Camp Lejeune EOD technician who confirmed that between 12 and 15 munitions items were found in the area between the bleachers and the steam plant in the area of the Parade Grounds while he was stationed at Camp Lejeune.

Personnel interviews have failed to confirm the former use of the project site as an established range. While ordnance is likely to be found in any given area of the base, the likelihood of W.P.T. Field having been used as a range is thought to be low due to its close proximity to the main administrative and industrial area of the base.

Figure 1-3 shows the proximity of Site UXO-08 to storage tanks, hazardous material/waste storage areas, solid waste management units, and Comprehensive Environmental Response, Compensation, and Liability Act sites. Several of the latter sites are in the immediate vicinity of Site UXO-08, primarily due to aboveground storage tanks associated with the industrial area.

There have been several previous site investigations dating back to 1983 within and in the vicinity of Site UXO-08. A significant study was the Remedial Investigation (RI) completed in 1994 at MCB Camp Lejeune Operable Unit (OU) 1. The operable unit is bordered by Holcomb Boulevard to the northwest, Sneads Ferry Road to the northeast, Main Service Road to the southwest, and Cogdels Creek to the southeast. OU 1 is approximately 690 acres in size and consists of three separate sites:

- Site 21, known as the Transformer Storage Lot 140;
- Site 24, known as the Industrial Fly Ash Dump; and
- Site 78, known as the Hadnot Point Industrial Area (refer to Figure 1-4).

Site 78, which houses the industrial area of MCB Camp Lejeune, is located between Sneads Ferry Road, Holcomb Boulevard, Duncan Street, and Main Service Road. Site 78 covers an area of approximately 590 acres and encompasses MRP Site UXO-08. Due to the industrial nature of the site, many spills and leaks occurred over the years, impacting the soil and groundwater in the area. Most of these spills and leaks have consisted of petroleum-related products and solvents from underground storage tanks (USTs), drums, and uncontained waste storage areas (Baker, 1994).

Groundwater sampling completed in 1993 – 1994 as part of the OU 1 RI indicated elevated levels of volatile organic compounds (VOCs) and several metals (including: arsenic, beryllium, barium, cadmium, chromium, lead, manganese, mercury, and nickel) above the standards. The shallow portion of the groundwater aquifer appeared to be most impacted by these contaminants. Concentrations of both halogenated and nonhalogenated VOCs were detected in shallow groundwater at the site and in the deeper water-bearing zone. Metals were detected throughout the site in the shallow groundwater and did not indicate a particular contaminant or pattern trend.

Soil sampling results from the Site 78 RI indicated that semivolatile organic compounds (SVOCs), pesticides, and metals were the predominant contaminants impacting soils. The most frequently detected SVOCs were polycyclic aromatic hydrocarbons (PAHs), which included phenanthrene, anthracene, fluoranthene, pyrene, benzo(b) fluoranthene, benzo(k) fluoranthene, benzo(a)pyrene, and benzo(g,h,i)perylene. These compounds are found in petroleum fuels such as fuel oil No. 2, diesel, and kerosene which are used for heating purposes, for fueling emergency generators, or for refueling base vehicles. Storage of these fuels in aboveground tanks or USTs was common at a number of buildings throughout Site 78. SVOC impact was primarily attributed to surface spills or subsurface tank leaks. Pesticide impact was attributed to routine spraying activities.

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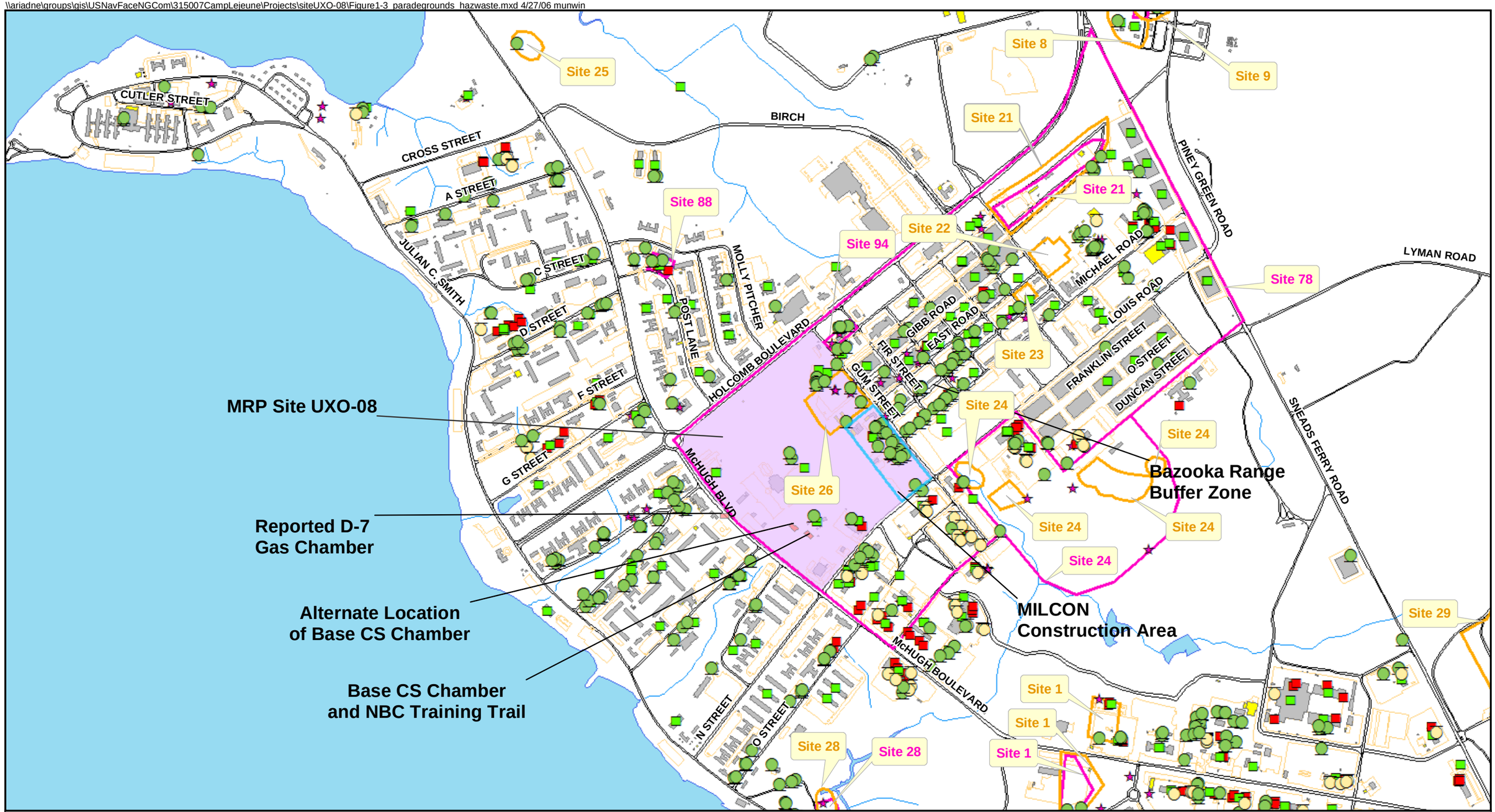


**Legend**

- Installation Area
- Structure Area
- Vehicle Parking Area
- Road Area
- Surface Water Course Centerline
- Surface Water Body Area
- PA/SI Work Area (Parade Ground Area)
- MILCON Construction Area
- Gas Chambers
- Above Ground Storage Tank
- Underground Storage Tank
- CERCLA Pre-remediation Sites
- CERCLA Sites
- Initial Assessment Sites
- Hazardous Materials Storage
- Hazardous Waste Storage
- SWMUs

N W E S

0 300 600 Meters

Figure 1-3
Proximity to Active Hazardous Wastes and Materials,
ASTs, USTs, LUSTs, SWMUs, CERCLA Sites, and IR Sites
Camp Lejeune, North Carolina

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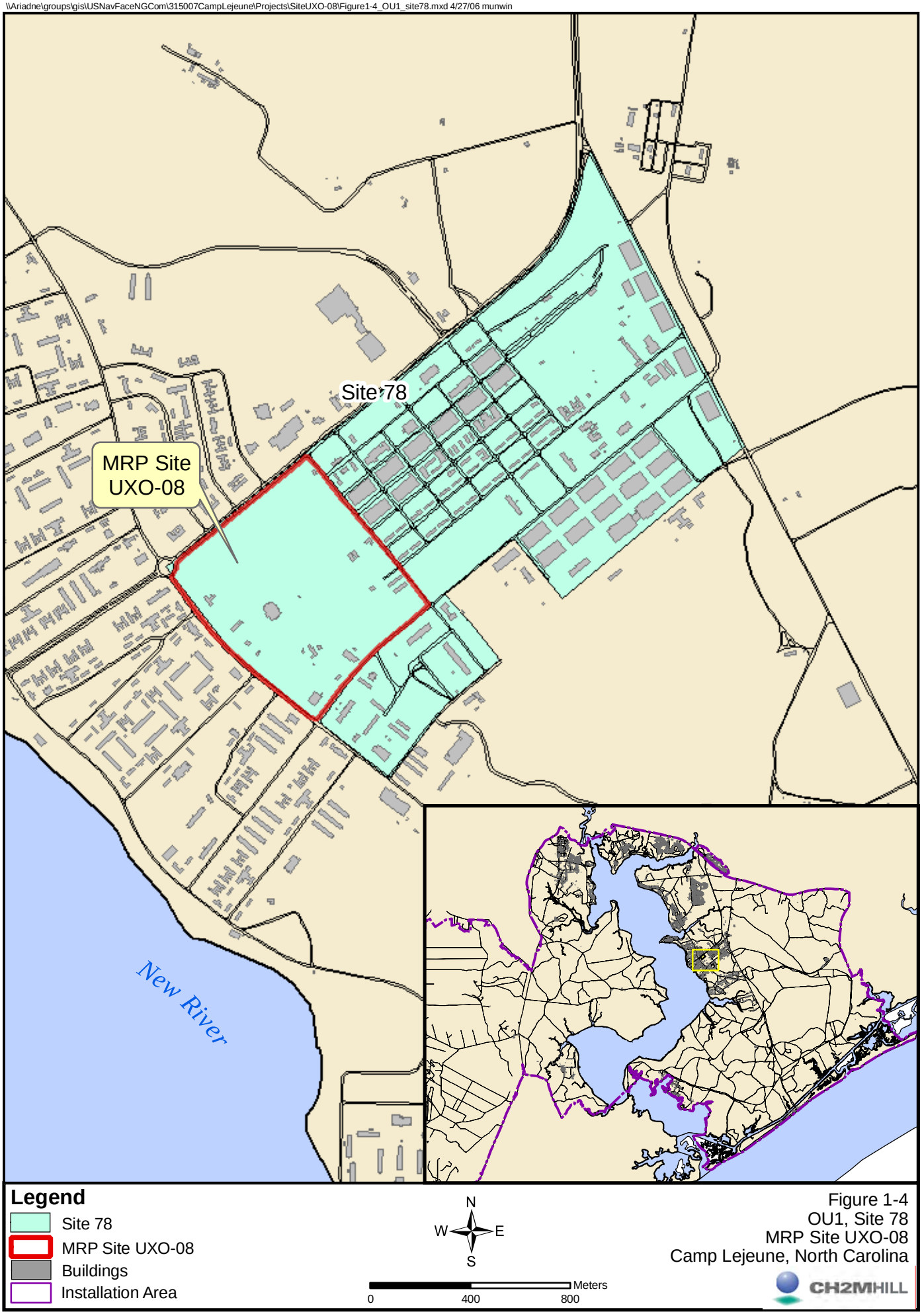


Figure 1-4
OU1, Site 78
MRP Site UXO-08
Camp Lejeune, North Carolina

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Barium, lead, and zinc, were the three most common metals detected at an order of magnitude or more above base-specific background levels. The specific sources of these metals were not determined as there was no history of disposal that would relate to these three contaminants. Analytical data indicated that VOCs and polychlorinated biphenyls (PCBs) were not significantly impacting soils at the areas investigated within Site 78.

The RI investigations also revealed that shallow groundwater at Site 78 had been impacted by organics and metals. The primary organic contaminants were VOCs, namely benzene, toluene, ethylbenzene, and total xylenes (BTEX); tetrachloroethene; trichloroethene (TCE); vinyl chloride; l,l-dichloroethene (DCE); cis-1,2-DCE; trans-1,2-DCE; and 1,2-dichloropropane. The highest overall concentrations of these compounds were detected near the northeastern portion of Site 78 and in wells located in the southwestern portion of the site. Halogenated compounds are typically associated with items such as solvents, degreasing agents, and paint strippers. Nonhalogenated compounds on the other hand, especially the lighter compounds such as BTEX, are typically associated with petroleum fuels (e.g., gasoline). A variety of these substances were stored or handled extensively through Site 78 at maintenance facilities, gas stations, fuel farms, and waste storage areas. Subsequently, the presence of VOCs in groundwater through accidental spills or leaking pipelines or tanks at Site 78 is plausible. Metals were detected in shallow groundwater throughout Site 78 at concentrations above the Federal and/or State standards

The intermediate wells sampled at Site 78 during the RI exhibited low levels of VOCs and only a few metals which exceeded federal and/or state standards. Benzene, TCE, 1,2-DCE, vinyl chloride, and dichloromethane were the most prevalent VOCs detected. The highest VOC concentrations were found in the northeastern and southern portions of Site 78. Several SVOCs, including naphthalene, acenaphthene, and carbazole, were detected in one well in the northern portion of Site 78. Beryllium, cadmium, lead, manganese, and nickel concentrations in the northeastern portion of the site exceeded the Federal and/or State groundwater standards.

The analytical data indicated that VOCs were the predominant contaminants in the deep wells. The most prevalent VOCs (i.e., both halogenated and nonhalogenated compounds) included benzene, cis-1,2-DCE, trans-1,2-DCE, and TCE. Wells located in the northeastern and southwestern portions of Site 78 exhibited the overall highest concentrations of VOCs. Further, one well located in the southwestern portion of the site exhibited elevated alpha chlordane (pesticide) levels above the state groundwater standards.

Several of the deep wells exhibited increased levels of VOCs over time (1991 to 1993). These wells are situated along a linear direction from southwest to northeast across Site 78, possibly suggesting deeper vertical migration of contaminants.

A review of groundwater data from the October 2004 sampling event at Site 78 indicates the presence of contaminant source areas upgradient (off-site and upgradient of the MILCON area). Specifically, well IR78-GW58 is impacted by BTEX (300 parts per billion [ppb] benzene; 4,900 ppb toluene; 5,800 ppb xylenes) and well IR78-GW52 is impacted by benzene and chlorinated solvents (1,300 ppb benzene; 4,300 ppb c-1,2-DCE; 1,200 ppb vinyl chloride).

## 1.5 Climate

The climate in the MCB Camp Lejeune area is characterized by short, mild winters with occasional short-duration cold periods and long, hot humid summers. Average annual net precipitation is approximately 50 inches. Ambient air temperatures generally range from 33 degrees to 53 degrees Fahrenheit (°F) in the winter months, and from 71°F to 88°F during the summer months. Winds are generally south-southwesterly in the summer and north-northwesterly in the winter (Water and Air Research, 1983). The hurricane season begins on June 1 and continues through November 30. Storms of non-tropical origins, such as frontal passages, local thunderstorms, and tornadoes, are more frequent and can occur year-round.

## 1.6 Geology and Hydrogeology

The topography of MCB Camp Lejeune is relatively flat with ground surface elevations ranging from mean sea level (msl) to 72 feet above msl. Most of the MCB Camp Lejeune lies between 20 and 40 feet msl. The SI work area is dominantly a flat area with surface elevation at 25 feet above msl. The 100-year floodplain elevation for this area of MCB Camp Lejeune is approximately 10 feet above msl.

Regional geology at MCB Camp Lejeune is discussed in the MCB Camp Lejeune Master Project Plans (CH2M HILL, 2005). Site-specific information is provided in the RI Report for OU 1 (Baker, June 1994). The SI work area is contained within OU 1 - Site 78, which was subjected to site investigation and remediation during the 1990s. Information related to site-specific geology and hydrology was obtained from the Final Remedial Report.

The land surface at MCB Camp Lejeune has been alternately exposed and submerged over time by water and marine deposits from an ancient inland sea. These deposits were laid down to form the weakly dissected alluvial plane. The deposits are mostly sands layered with clay and marine shells. Elevations range from 0 feet above sea level at the waterways to 72 feet above msl between the New River and U.S. Route 17. MCB Camp Lejeune consists of both broad, level flatlands and gently rolling hills. Nearly 30 percent of the soils at MCB Camp Lejeune are considered hydric. Leon fine sand, Mukalee Loam, and Murville fine sand are the most common hydric soils. Baymeade fine sand, a nonhydric soil, is the most prevalent soil type at the installation and encompasses 18 percent of the land (Department of the Navy, July 2005).

A soil survey for Onslow County indicates that the Baymead Foreston Stallings soil association is predominant in the Camp Johnson portion of Camp Lejeune. This association is typically found on level to gently sloping areas and ranges from somewhat poorly to well-drained with loamy subsoil throughout. Four soil map units are mapped in the study area. They are: Baymeade-Urban Complex, 0 to 6 percent slopes (BmB), Baymeade fine sand 0 to 6 percent slopes (BaB), Wando fine sand 1 to 6 percent slopes (WaB), and Craven fine sandy loam (CrC), 4 to 8 percent slopes. The affected soil map units have not been classified either as hydric soils or prime farmland by the Natural Resources Conservation Service (MCB Camp Lejeune, July 2002). Most soils within this area have been previously disturbed due to a history of intensive use.

The upper portion of the River Bend Formation, which underlies the Quaternary-age sediments, is composed of sands, silts, shell and fossil fragments, and trace amounts of clay. The River Bend Formation overlies the Eocene Castle Hayne Formation. The Castle Hayne Formation consists of both poorly indurated and well-indurated biomicrite and biomicrudite limestone (Harris and Zullo, 1991). Thickness of the Castle Hayne Formation ranges between 150 feet and over 450 feet locally at MCB Camp Lejeune (Cardinell et al., 1993).

Shallow soil conditions are generally uniform throughout the SI work area. In general, the shallow soils consist of unconsolidated deposits of silty and clayey-sand, silt, and clay. These soils represent the Quaternary age "undifferentiated" Formation which characterizes the shallow water table aquifer. Sands are fine to coarse-grained and contain varied amounts of silt (5 percent to 50 percent) and clay (5 percent to 20 percent). Results of the standard penetration tests (commonly referred to as "blow counts", ASTM 1586) indicate that the sands have a relative density of loose to dense. Based on field observations of the Soil Conservation Service (SCS), the sands classify as silty sand (SM) and/or clayey sand (SC) under the Unified Soil Classification System (USCS). Clays are plastic to nonplastic, contain varied amounts of silt (some of which contained organic matter) and clay (5 percent to 25 percent), and classify as clay (CL) or high plasticity clay (CH) under the USCS. Standard penetration results for cohesive soils (silts and clays) indicate a relative density of medium dense to stiff.

According to the SCS, the area is underlain by a single distinct soil unit. The Urban soil unit typically consists of areas that are more than 85 percent covered by buildings, streets, parking lots, and associated urban areas. Due to extensive urbanization, the natural soil properties and topographic relief of the Urban complex have been altered. The infiltration rate of the Urban complex is low and, as a result, nearly all precipitation runs off (Baker, June 1994).

The surficial aquifer lies in a series of sediments, primarily sand and clay, which commonly extend to depths of 50 to 100 feet. This aquifer is not used for water supply at MCB Camp Lejeune. The principal water supply aquifer for MCB Camp Lejeune lies in a series of sand and limestone beds located between 50 and 300 feet below land surface. This series of sediments is generally known as the Castle Hayne Formation. The Castle Hayne Formation is approximately 150 to 350 feet thick in this vicinity and contains the most productive aquifer in North Carolina. Onslow County and MCB Camp Lejeune lie in an area where the Castle Hayne Formation contains freshwater, although the proximity of saltwater in deeper layers just below this aquifer formation and in the New River estuary is of concern in managing water withdrawals from the aquifer.

During the RI investigation in 1994, groundwater was encountered at varying depths throughout OU 1. This variation in groundwater depth may be attributed to topographic changes. In general, groundwater was encountered between 4 and 14 feet below ground surface (bgs). A higher water table was typically encountered near the southwestern portion of the SI work area near Cogdels Creek (Baker, 1994).

Natural drainage has been altered by the installation of drainage ditches, storm sewers, buildings, and extensive paving. Surface runoff not intercepted by a manmade structure from southern portions of Site UXO-08 drains into Cogdels Creek which drains into the New River. The New River flows in a southerly direction and empties into the Atlantic

Ocean through the New River Inlet. The New River and the southern portions of Cogdels Creek are tidally influenced (Baker, 1994).

SECTION 2

# Technical Management Plan

## 2.1 Project Personnel, Organization, Reporting, and Schedule

### 2.1.1 Project Organization

The key organizations involved in this project are NAVFAC, the North Carolina Department of Environment and Natural Resources (DENR), and CH2M HILL, Inc. Project execution will be conducted by CH2M HILL and its subcontractors. CH2M HILL will issue subcontracts for MEC avoidance support, direct push soil sampling, laboratory analytical services, data validation services, and support facilities.

#### CH2M HILL — Prime Contractor

As the prime contractor, CH2M HILL is the primary point of contact with NAVFAC. CH2M HILL will manage the overall project, providing day-to-day oversight and related program management support to execute the project successfully. Project duties controlled by CH2M HILL include the following:

- Project planning, implementation, and reporting
- Subcontractor selection, management, and control
- Program- and project-level QC
- Program- and project-level health and safety
- Site management
- Work Plan and Explosives Safety Submission (ESS) Preparation
- Technical direction for geophysical operations, geographical information system (GIS), and database management
- Performance of field sampling activities
- Analysis of data and preparation of SI report
- Project closeout

#### USA Environmental — MEC Subcontractor

USA Environmental (referred to herein as USA) will provide qualified unexploded ordnance (UXO) Technicians for MEC avoidance during intrusive field operations. Specific project duties will include the following:

- Train field personnel in appropriate MEC safety procedures prior to initiation of field activities

- Escort land-surveying subcontractor personnel
- Engage in subsurface MEC avoidance for soil sampling
- Coordinate with Marine Corps EOD personnel in the event MEC is discovered during the investigation

USA will provide the labor, equipment, and tools required for the work described above.

### TBD — Geophysical Services Subcontractor

The geophysical services subcontractor will provide trained personnel for geophysical investigation services. Specific project duties assigned to the geophysical services subcontractor include the following:

- Implementing the GPO according to the GPO work plan (refer to GIP in Appendix C)
- Perform DGM services according to the GIP (refer to Appendix C), including the DGM survey, data processing and interpretation, and preparation of geophysical anomaly maps

The geophysical services subcontractor will provide the labor, equipment, and tools required for the work described above.

### TBD — Direct Push Soil Sampling Subcontractor

Soil sampling will be accomplished utilizing a subcontractor implementing Direct Push Technology (DPT) to collect soil samples within the 15-acre construction project footprint. Specific project duties assigned to the DPT subcontractor include the following:

- Perform DPT services according to this Work Plan and under the direction of the Field Team Leader.
- Prepare collected samples for shipment to the selected analytical laboratory in accordance with this Work Plan and under the direction of the Field Team Leader.
- Perform all intrusive activities under the supervision and direction of the UXO Technician.

The DPT services subcontractor will provide the labor, equipment, and tools required for the work described above.

### TBD — Analytical Laboratory Subcontractor

Groundwater and soil will be sampled by CH2M HILL personnel. A North Carolina-certified laboratory will be used for all chemical analyses. Environmental samples will be collected in accordance with MCB Camp Lejeune Master Project Plans (CH2M HILL, 2005). The Analytical Laboratory subcontractor is responsible for providing facilities and testing equipment that complies with testing standards and implementing an approved laboratory quality assurance/quality control (QA/QC) program.

### TBD — Data Validation Subcontractor

Data validation will be conducted by a subcontracted data validation service which will validate the complete laboratory data packages using the latest versions of the U.S. Environmental Protection Agency (EPA) National Functional Guidelines.

## 2.1.2 Project Personnel

The reporting relationships between key project personnel are illustrated in the organization chart provided as Figure 2-1. Table 2-1 provides contact information for project team members. The roles and responsibilities of the key personnel are discussed below.

- Program Manager—Doug Dronfield will provide program management support of this CTO and will ensure that all contract requirements are met during execution of this project
- Senior Technical Consultant—Ben Redmond will serve as senior technical consultant on MRP matters.
- Activity Manager—Matt Louth will coordinate the implementation of all CTOs at MCB Camp Lejeune. Mr. Louth will ensure that information is shared between CTO project teams and will communicate with the NAVFAC Project Manager (PM) concerning the overall MCB Camp Lejeune activity
- Project Manager—Tom Roth will have overall CH2M HILL responsibility for technical support and oversight, budget and schedule review and tracking, invoice review, personnel resources planning and allocation, and project coordination. Mr. Roth will also coordinate field activities with project field personnel and act as CH2M HILL's primary point of contact with NAVFAC and MCB Camp Lejeune personnel during implementation of this CTO.
- Corporate Munitions Response (MR) Safety and QC Officer—Dan Young, Certified Safety Profession (CSP), will oversee the field team leader (FTL)'s implementation of the HSP (refer to Appendix B) and QC Plan (refer to Section 4) to ensure that they meet the specific needs of the project and that appropriate health and safety and QC requirements are defined and properly executed.
- Program Health and Safety Manager—Michael Goldman, Certified Industrial Hygienist (CIH), will support the implementation of the HSP (refer to Appendix B) to ensure that it meets all specific needs of the project and that appropriate health and safety requirements are defined
- Field Team Leader (FTL) – The FTL will be CH2M HILL's onsite representative to coordinate and oversee the activities of field support personnel and subcontractor personnel. The FTL is also responsible for implementation of and compliance with HSP and QC requirements during the field effort.
- Program Geophysicist—Tamir Klaff will be responsible for ensuring that the QC procedures and objectives for the GPO and geophysical investigations are implemented and met. Mr. Klaff will work closely with the geophysical services subcontractor during the execution of this CTO and will provide oversight of the geophysical services subcontractor and will be responsible for the acceptance of their geophysical data.

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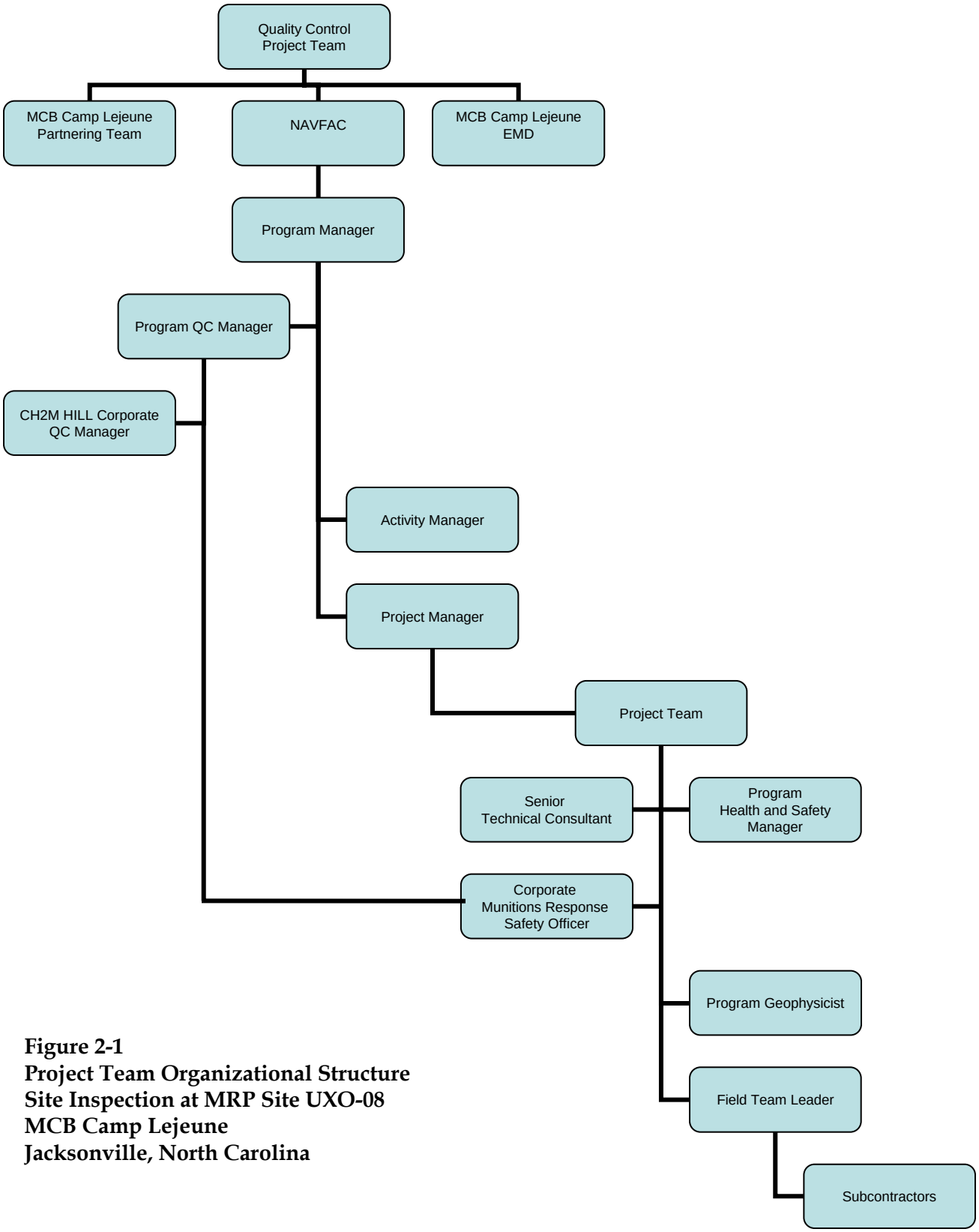


**Figure 2-1**
**Project Team Organizational Structure**
**Site Inspection at MRP Site UXO-08**
**MCB Camp Lejeune**
**Jacksonville, North Carolina**

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TABLE 2-1
Project Personnel Contact Information
*SI Work Plan, Site UXO-08, Bazooka Range and Gas Chambers*

| Name/Title/Organization | Mailing Address | Telephone/Fax/E-mail |
|---|---|---|
| Doug Dronfield<br>Program Manager<br>CH2M HILL | 13921 Park Center Road<br>Suite 600<br>Herndon, VA 20171-3241 | 703-471-1441 (office)<br>703-471-1508<br>Doug.Dronfield@ch2m.com |
| Ben Redmond<br>Market Segment Director<br>Senior Technical Consultant<br>CH2M HILL | 151 Lafayette Drive<br>Suite 110<br>Oak Ridge, TN 37830 | 865-483-9032, ext. 535 (office)<br>865-384-5511 (fax)<br>Ben.Redmond@ch2m.com |
| Matt Louth<br>Activity Manager<br>CH2M HILL | 5700 Cleveland Street<br>Suite 101<br>Virginia Beach, VA 23462 | 757-518-9666 (office)<br>757-460-4592 (fax)<br>Matt.Louth@ch2m.com |
| Thomas M. Roth, P.E.<br>Project Manager<br>CH2M HILL | 2607 LaVista Road<br>Decatur, GA 30033-1728 | 404-474-7640 (office)<br>404-259-6674 (cell)<br>770-604-9183 (fax)<br>Tom.Roth@ch2m.com |
| Michael Goldman, C.I.H.<br>Program H&S Manager<br>CH2M HILL | 115 Perimeter Center Place NE<br>Suite 700<br>Atlanta, GA 30346-1278 | 770-604-9095 (office)<br>770-604-9183 (fax)<br>Michael.Goldman@ch2m.com |
| Dan Young, CSP<br>Corporate MR Safety & QC Officer<br>CH2M HILL | 10687 Aloe Lane<br>Lillian, AL 36549 | 251-962-2963 (home office)<br>256-527-5662 (cell)<br>Dan.Young@ch2m.com |
| Tamir Klaff<br>Program Geophysicist<br>CH2M HILL | 490 Marshall Dr<br>Leesburg, VA 20176 | 703-471-1441 (office)<br>202-415-9472 (cell)<br>703-471-1508 (fax)<br>Tamir.Klaff@ch2m.com |

### 2.1.3 Project Schedule

Modification 2 to CTO-109, which authorizes CH2M HILL to perform the SI at Site UXO-08, was issued by NAVFAC on September 27, 2005. Modification 3, which provides funding for additional sampling and geophysical mapping, was issued by NAVFAC on May 11, 2006.

The schedule for performing the SI is provided as Figure 2-2. This schedule will be revised as the project progresses.

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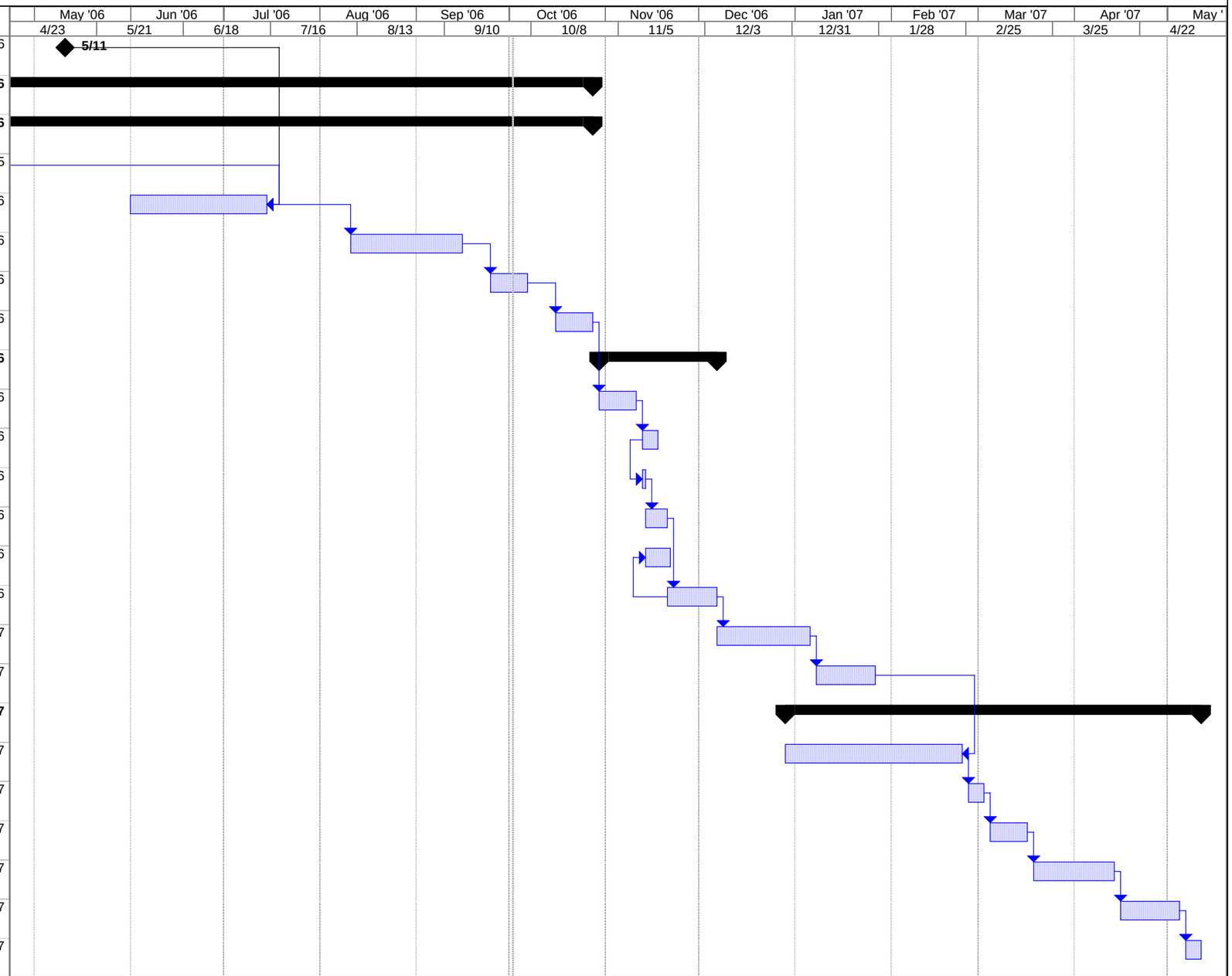
**Project Schedule**
**Site Inspection at MRP Site UXO-08**
**Former Bazooka Range & Gas Chambers**
**MCB Camp Lejeune, North Carolina**

| ID | Task Name | Duration | Start | Finish |
|---|---|---|---|---|
| 1 | CTO-109, Mod 3 Issued | 0 days | Thu 5/11/06 | Thu 5/11/06 |
| 2 | **Work Plan** | **247 days** | **Mon 11/7/05** | **Fri 10/27/06** |
| 3 | **SI Work Plan** | **247 days** | **Mon 11/7/05** | **Fri 10/27/06** |
| 4 | Archives Search | 20 days | Mon 11/7/05 | Tue 12/6/05 |
| 5 | Draft WP | 30 days | Thu 6/1/06 | Fri 7/14/06 |
| 6 | Regulatory Review of Draft WP | 25 days | Fri 8/11/06 | Fri 9/15/06 |
| 7 | Final WP | 10 days | Mon 9/25/06 | Fri 10/6/06 |
| 8 | Regulatory Approval of Draft WP | 10 days | Mon 10/16/06 | Fri 10/27/06 |
| 9 | **Field Activities - PA/SI** | **26 days** | **Mon 10/30/06** | **Wed 12/6/06** |
| 10 | Mobilization | 10 days | Mon 10/30/06 | Fri 11/10/06 |
| 11 | Establish DGM Survey Control | 5 days | Mon 11/13/06 | Fri 11/17/06 |
| 12 | Geophysical Proveout | 1 day | Mon 11/13/06 | Mon 11/13/06 |
| 13 | DGM - Towed Array | 5 days | Tue 11/14/06 | Mon 11/20/06 |
| 14 | DGM - Single Coil | 6 days | Tue 11/14/06 | Tue 11/21/06 |
| 15 | Environmental Sampling | 10 days | Tue 11/21/06 | Wed 12/6/06 |
| 16 | Sample Analysis | 20 days | Thu 12/7/06 | Fri 1/5/07 |
| 17 | Data Validation & Review | 15 days | Mon 1/8/07 | Fri 1/26/07 |
| 18 | **Task 8 – Reporting** | **95 days** | **Fri 12/29/06** | **Fri 5/11/07** |
| 19 | Submit Draft Report | 40 days | Fri 12/29/06 | Fri 2/23/07 |
| 20 | Government Review of Draft Report | 5 days | Mon 2/26/07 | Fri 3/2/07 |
| 21 | Submit Draft-Final Report | 10 days | Mon 3/5/07 | Fri 3/16/07 |
| 22 | Regulatory Review of Draft-Final Report | 20 days | Mon 3/19/07 | Fri 4/13/07 |
| 23 | Submit Final Report | 15 days | Mon 4/16/07 | Fri 5/4/07 |
| 24 | Government Approval of Final Report | 5 days | Mon 5/7/07 | Fri 5/11/07 |




Project: MRP Site UXO-08
Date: Mon 10/2/06

Task | Progress | Summary | External Tasks | Deadline
Split | Milestone | Project Summary | External Milestone

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## 2.2 Technical Approach

The work under this CTO has been divided into the following seven tasks, which are described in the remainder of this subsection:

- Task 1—Project Planning
- Task 2—Data Evaluation
- Task 3—Explosives Safety Submission
- Task 4—Site Investigation
- Task 5—Sample Management and Validation
- Task 6—GIS
- Task 7—Reporting

Handling and disposal of MEC will not be conducted by CH2M HILL or its contractors during the execution of the activities described in this SI Work Plan. Although not anticipated, if suspected MEC is found during field activities, field personnel will stop work, evacuate the area, and immediately notify MCB Camp Lejeune EOD. These procedures are discussed in more detail in the HSP (Appendix B).

### 2.2.1 Task 1 – Project Planning

This task includes project management, meetings, work plan preparation, and subcontractor procurement.

Project management includes all work necessary for controlling the project budget and schedule. This includes monthly status reports and invoicing, as well as all other administrative tasks needed for project performance.

Four meetings are planned for during the course of this project. The meetings will be held as necessary to discuss proposed field activities, investigation findings, and project status. The meetings are planned to be held at MCB Camp Lejeune, CH2M HILL's Virginia Beach office, or at other locations as necessary.

Two versions of this work plan are scoped under this task. A draft work plan will be submitted for NAVFAC, EPA Region 4, and DENR review, and a final work plan will be prepared that incorporates NAVFAC, EPA Region 4, and DENR review comments.

Subcontractor procurement is also included under this task. Anticipated subcontractor services include MEC support, DPT services, geophysical services, laboratory analysis, and data validation.

### 2.2.2 Task 2 – Data Evaluation

This task includes the archival records search and evaluation of sampling data collected for this project. The archival records search was performed during preparation of this work plan and the results are presented in Appendix A.

### 2.2.3 Task 3 – Explosives Safety Submission

An ESS will be prepared for use in future MEC investigations, if any are conducted. The ESS will be prepared as a separate document.

The scope of work covered by this work plan does not involve the handling, demolition, or disposal of MEC. MEC avoidance procedures, as presented in the HSP (Appendix B) will be followed during intrusive activities conducted under this SI Work Plan. The work to be conducted for this SI does not meet the requirements for an ESS as prescribed in Naval Operations Instructions (OPNAVINST) 8020.15, "Explosives Safety Review, Oversight, and Verification of Response Actions Involving Military Munitions".

### 2.2.4 Task 4 – Site Investigation

All field investigation activities will be performed under this task. The scope of the field investigation and the technical approach is presented in Section 3. The primary field investigation activities are the following:

- MEC avoidance support for intrusive investigation activities
- Digital geophysical mapping
- Environmental sampling

### 2.2.5 Task 5 – Sample Management and Validation

This task includes management of environmental sample data from the time the samples are collected until the validated data is received and incorporated into the project reports. This includes sample tracking from field collection through the receipt of validated data, coordination and communications with the laboratory and data validator, and preparation and delivery of the site data sets to MCB Camp Lejeune.

Samples will be tracked from the field using chain-of-custody (COC) forms. Tracking will verify that all samples that were required were collected and sent to the laboratory. It will also determine that samples were analyzed for the appropriate parameters and this information was sent and received by the validator. Finally, upon receipt of the validated data, verification will assure that all required samples were collected, analyzed, laboratory data validated, and received by CH2M HILL in the required electronic format.

Data validation will be conducted by an independent subcontracted data validation service, validated per EPA guidance, National Functional Guidelines for organic and inorganic data validation (1999, 2004). A validation report will be expected within 3 weeks of the validator's receipt of the laboratory data.

CH2M HILL will submit electronic updates to the MCB Camp Lejeune Environmental Information Management System in accordance with its electronic data deliverable format. This will include location coordinates for newly installed or abandoned wells and analytical data. All data will be submitted within 30 days following the completion of the site database.

### 2.2.6 Task 6 – Geographical Information System

All data will be collected in preparation for the creation of a GIS tailored for the specific SI needs of the site. All geophysical mapping data collected in support of the SI will be created using a software platform that will allow it to be loaded directly into the MEC GIS system. The main purpose of the GIS is to assemble all the data required to associate the non-intrusive subsurface geophysics investigative data with its correct geographical location, the relational database, mapping, and remote sensing data. The GIS tools are used to manage the geophysical components of the project, assemble data for the administrative record, and help determine areas requiring further investigation.

CH2M HILL will also input the collected mapping data into the existing ArcView GIS for MCB Camp Lejeune. This data includes ArcView project and shape files that best delineate the area on the basis of uses, site conditions, and other information gathered during the study. CH2M HILL will develop a project base map that will include all geophysical grids that were digitally mapped during the SI.

### 2.2.7 Task 7 – Reporting

A draft SI Report will be prepared to document the findings of the field investigation. The report will summarize all field activities, evaluate the collected geophysical and environmental data, and present a screening human health and ecological risk assessments for residential use. Following NAVFAC and DENR review, a final SI Report will be prepared that incorporates review comments.

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SECTION 3

# Field Investigation Plan

## 3.1 Overall Approach

In keeping with the SI objectives identified in Section 1 of this Work Plan, the objectives for this field investigation are to:

- Identify the presence and nature of any HTW contamination that may exist in the 15-acre MILCON area
- Determine the presence or absence of MC in surface soil at Site UXO-08
- Evaluate the number and density of anomalies that could potentially represent subsurface MEC, while providing geophysical data for future MEC intrusive investigations or removal actions

The field investigation will accomplish the above objectives through the following activities, which will be conducted in accordance with Navy CLEAN Standard Operating Procedures (SOPs), CH2M HILL SOPs, and the MCB Camp Lejeune Master Project Plans (CH2M HILL, 2005):

- Collect surface and subsurface soil samples using DPT from seven locations in the proposed 15-acre construction footprint for analysis of HTW contaminants
- Collect surface and subsurface soil samples using DPT from one location near the reported D-7 gas chamber and from one location near the base CS chamber and NBC training trail for analysis of HTW contaminants
- Collect surface soil samples from 20 additional locations across Site UXO-08 for analysis of MC
- Collect groundwater samples and groundwater level measurements from five existing monitoring wells plus one upgradient monitoring well in the area of the proposed 15-acre construction footprint
- Perform DGM mapping of 45 acres using towed-array methods and perform DGM mapping of 14 acres using single-coil manually-towed methods
- Interpret and present the data in the SI Report for the site.

The field investigation activities are described below. Detailed procedures are presented in the MCB Camp Lejeune Master Project Plans (CH2M HILL, 2005), where appropriate.

## 3.2 Site Preparation and Restoration

The following subsections describe the procedures associated with site preparation, including mobilization of personnel and equipment, and preparation for intrusive environmental investigation activities, and preparation for DGM.

### 3.2.1 Mobilization

A mobilization period will include identifying, briefing, and mobilizing staff, as well as securing and deploying equipment. Mobilization activities include general activities and a kickoff and safety meeting.

#### General Activities

- Identify/procure, package, ship, and inventory project equipment, including geophysical equipment, sampling equipment, hand tools and supplies
- Coordinate with local agencies, including MCB Camp Lejeune, DNER, police, hospital, and fire department, as appropriate
- Coordinate communications and other logistical support
- Finalize operating schedules
- Test and inspect equipment
- Conduct site-specific training on the work plan, HSP, and MEC procedures and hazards
- Verify that all forms and project documentation are in order and project team members understand their responsibilities regarding completing project-reporting requirements

#### Kickoff/Safety Meeting

During mobilization, a kickoff and site safety meeting will be conducted. This meeting will include a review of this work plan and a review and acknowledgment of the HSP by all site personnel. Additional meetings will occur as needed, as new personnel, visitors, and/or subcontractors arrive at the site.

### 3.2.2 Establishment of Global Positioning System (GPS) Base Station Point for DGM Activities

A professional land surveyor, registered in the state of North Carolina, will establish a local base point on which the DGM subcontractor can set up their GPS base station. The land surveyor will also survey the coordinates of all soil sampling locations.

### 3.2.3 Site Restoration and Demobilization

#### Site Restoration

Any damage caused by equipment or other site activities will be repaired and the site restored to its original condition.

### Demobilization

Full demobilization will occur when the project is completed and appropriate QA/QC checks have been performed. Personnel who are no longer needed during the course of field operations may be demobilized prior to the final project completion date. The following will occur prior to demobilization:

- All areas to be geophysically mapped will be verified as completed
- COC records will be reviewed to ensure that all samples were collected as planned and were submitted for appropriate analyses
- Restoration of the site to an appropriate level will be verified
- All equipment will be inspected, packaged, and shipped to the appropriate location

## 3.3 Geophysical Investigation Plan

Digital geophysical mapping will be conducted over 59 acres of Site UXO-08. The site will be divided into a grid network with a node spacing of 100 feet as shown on Figure 3-1. Up to 45 acres will be mapped using towed-array methods and up to 14 acres will be mapped using single-coil manually-towed methods. The locations and actual acreages surveyed by each method will be based on field conditions, including the presence of utilities, buildings, fences, and other cultural features that may interfere with the collection of DGM data.

The GIP provided in Appendix C provides details of the equipment, approach, methods, operational procedures and quality control to be used in performing the geophysical investigations at Site UXO-08. A GPO will be conducted at the test plot previously constructed at MRP Site UXO-04, Knox Trailer Park. The GPO Plan is provided as an attachment to the GIP in Appendix C.

## 3.4 Geospatial Information and Electronic Submittals

### 3.4.1 General Information

This subsection describes the methods, equipment, and accuracy requirements for conducting location surveys and mapping for the investigation at MRP Site UXO-08. This plan also identifies the requirements for the electronic submittal of documents, mapping, and GIS data.

All geospatial data will conform to the computer-aided drafting and design (CADD)/GIS Technology Center Spatial Data Standards for Facilities Infrastructure and Environment and will be provided in metric units.

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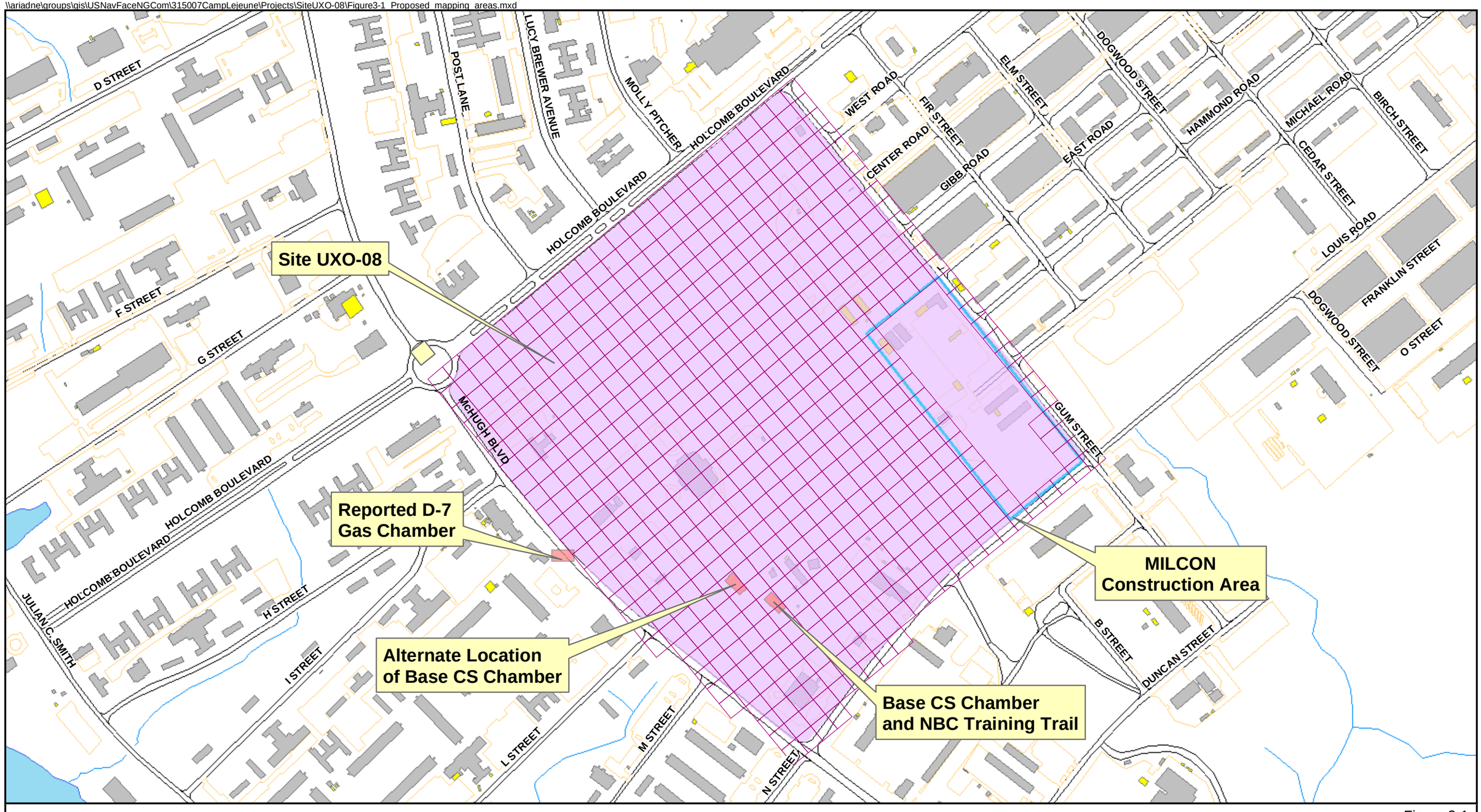


**Legend**

- PA/SI Work Area (Parade Ground Area)
- MILCON Construction Area
- Gas Chambers
- Buildings
- Vehicle Parking Area
- Road Area
- Towed Array
- Single Coil Manually-Towed

N
W E
S

0 150 300 Meters

0 100 200 400 600 Feet

Figure 3-1
Digital Geophysical Mapping Grid Layout
Site UXO-08
Camp Lejeune, North Carolina

CH2MHILL

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### 3.4.2 Surveying

Horizontal and vertical control of Class I, Third Order or better will be established for the network of monuments at the site. Horizontal control will be based on the metric system and referenced to the North American Datum of 1983 (NAD83) and the Universal Transverse Mercator Grid System. Vertical control will also be based on the metric system and referenced to the North American Datum of 1988 (NAVD88).

If new control points are established, they will be of a permanent nature to allow for future recoverability. All control points will be established using iron or steel pins, concrete monuments, or other permanent construction method.

A professional land surveyor licensed in the State of North Carolina will certify all survey data. The professional land surveyor will use either real time kinematic (RTK) differential global positioning system (DGPS) or conventional geodetic survey instruments to collect or emplace points. Upon completion of the field work, the eastings and northings ($x$,$y$) for all control points and sampling locations will be presented in a certified letter or drawing, along with an electronic submittal of the same.

Geophysical surveying at the project site will be conducted by the geophysical subcontractor using RTK DGPS connected to their DGM systems.

### 3.4.3 Geographic Information System Incorporation

Environmental Systems Research Institute, Inc. (ESRI)–compliant formats (shapefiles, coverages, or geodatabases) will be used to present GIS data during the project, with supporting tabular data provided in Microsoft Excel format, Microsoft Access format, or both, as needed.

### 3.4.4 Plotting

All of the control points recovered and/or established at the site will be plotted at the appropriate coordinate points on reproducible electronic media for production of planimetric or topographic maps at scales appropriate for the parcel size being described.

### 3.4.5 Mapping

The location, identification, coordinates, and elevations of all control points that are recovered and/or established at the site will be plotted on one or more site maps. Each control point will be identified on the map by its name and number and the final adjusted coordinates.

Each map will include a legend showing the standard symbols used for the mapping, a north arrow, and a title block.

### 3.4.6 Digital Data

Location information will be collected as part of the DGM survey and will be sufficient to accurately relocate the position of geophysical anomalies in the field and accurately plot the position of each anomaly in the GIS.

### 3.4.7 Computer Files and Digital Data Sets

All final document files, including reports, figures, and tables, will be submitted in electronic format. These files will be compatible with Microsoft Office 97 or later formats or in Portable Document Format (PDF) on CD-ROM.

## 3.5 Field Sampling Plan

### 3.5.1 Field Operations

In order to identify the presence and nature of any HTW or MC contamination that may exist in the planned MILCON area, groundwater and soil samples will be collected for laboratory analysis. This effort will include the collection of groundwater samples from six existing monitoring wells and the collection of seven subsurface soil samples using DPT. One additional subsurface soil sample will be collected in the reported location of the former D-7 Gas Chamber, and one additional subsurface soil sample will be collected in the location of the former Base CS Chamber and NBC Training Trail.

In order to evaluate the potential presence of MC contamination resulting from past use of munitions at Site UXO-08, surface soil samples will be collected from 20 locations across the site. These samples will be analyzed for MC.

Soil and groundwater samples will be collected as described below and in accordance with the Master Project Plans (CH2M HILL, 2005). MEC anomaly avoidance procedures, as described in the HSP, will be used during soil sampling activities.

The sampling plan is summarized in Table 3-1.

#### Surface Soil Sampling

Surface soil samples for MC analysis (explosives residues) will be collected following the "TR-02-1" approach, which is summarized below and described in the USACE Technical Report ERDC/CRREL TR-02-1, *Guide for Characterization of Sites Contaminated with Energetic Materials* (Thiboutot, et al., 2002).

Sample locations will be determined following a review of the DGM data. Up to 20 sample locations will be placed in areas where geophysical anomalies indicate the potential presence of subsurface MEC. If fewer than 20 such anomalies result from the DGM effort, additional sample locations, to provide a total of 20 samples, will be located across the site to provide as extensive coverage of the site as possible.

Each sampling location will be defined as an area up to 1 meter x 1 meter in size. Coordinates of the sampling location will be based on the center of the sampling area. Sampling personnel will record the dimensions of each sampling location in the field logbook.

TABLE 3-2
Summary of Sampling Program
Site Inspection Work Plan, Site UXO-08, Bazooka Range and Gas Chambers
*MCB Camp Lejeune*
*Jacksonville, North Carolina*

| Sample Media | Sample ID Number | Sample Depth/Location and Rationale | Analysis | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | VOCs | SVOCs | Pesticides/ PCBs | Explosives Residues | Perchlorate | TPH | Total TAL Metals | Cyanide | Filtered TAL Metals | TOC |
| Direct Push Soil | MR08-SS01-T-B through MR08-SS10-T-B | Collected from a 2 feet interval just above the water table at each location shown on Figure 3-2.<br><br>Will allow for characterization of soil across site, as well as characterization at locations of potential historical dumping and depositional locations at the beginning of drainage points (i.e., streams). Collocated with some monitoring wells. | x | x | x | x | | x | x | x | | x |
| Surface Soil | MR08-SS11-T-B through MR08-SS30-T-B | Collected from an interval of 0 - 2 inches bgs. Locations to be determined based on DGM results.<br><br>Will allow for characterization of munitions constituents in surface soil across the site. | | | | x | | | | | | |
| Monitoring Well Groundwater | IR78-GW01-06A, IR78-GW02-06A, IR78-GW04-1-06A, IR78-GW11-06A, IR78-GW42-06A, IR78-GW56-06A | From existing monitoring wells IR78-GW01, IR78-GW02, IR78-GW04-1, IR78-GW11, IR78-GW42, IR78-GW56 shown on Figure 3-1.<br><br>Will allow for characterization of groundwater across site, including upgradient and downgradient locations. | x | x | x | x | x | x | x | x | x | |

Notes and Abbreviations

For Direct Push Soil Samples: "T-B" refers to the top depth and bottom depth of the sample interval

For Monitoring Well Groundwater Samples: 05A Refers to the samples being collected in 2005, and that they are the first round of samples collected from the wells.

TCL = Target Compound List
VOC = Volatile organic compounds
SVOC = Semivolatile organic compounds
PCBs = Polychlorinated biphenyls
TDS = Total dissolved solids (TDS)
TAL = Target Analyte List
TPH = Total petroleum hydrocarbons
TOC = Total organic carbon
TOX = Total organic halogens

Multi-increment composite soil samples will be collected by compositing a minimum of ten sample increments from random locations within each 1 meter x 1 meter (maximum) sampling location. The sample increments will be approximately equal in the amount of soil, which will be collected from depths of 0 to 2 inches in accordance with Appendix D, SOP A-1, *Shallow Soil Sampling*. The sample increments at each location will be composited into a single sample following the procedures in Appendix D, SOP A-4, *Homogenization of Soil and Sediment Samples*, prior to being transferred to the appropriate sample containers.

### Subsurface Soil Sampling

A DPT rig will be used to collect soil samples above the water table in accordance with CH2M HILL SOPs, and the Master Project Plans (CH2M HILL, 2005). MEC anomaly avoidance procedures will be used as described in the HSP.

Nine subsurface soil samples will be collected from just above the water table at the approximate locations shown on Figure 3-2. Actual locations will be affected by subsurface geophysical readings as well as site conditions during field activities. At least two sampling locations are biased towards the former locations of the gas chambers; the remaining samples are in the MILCON area and are randomly located or may be biased depending on visual observation of the site during field activities. Locations will be numbered in the field. Actual sample location coordinates will be determined using an RTK DGPS unit in the field. QA/QC samples will be collected per Section 3.5.2 below.

Samples will be analyzed by a fixed-base laboratory for the following parameters:

- Target compound list (TCL) volatile organic compounds (VOCs)
- TCL semivolatile organic compounds (SVOCs)
- TCL pesticides and PCBs
- Explosives residues
- Target analyte list (TAL) metals and cyanide
- Total petroleum hydrocarbons (TPH)
- Total organic carbon (TOC)

The water table elevations will be evident by the soil cores removed at each location. The water table is expected to be approximately 4 feet bgs or greater throughout the site.

### Monitoring Well Sampling

**Monitoring Well Locations and Depths.** Figure 3-2 depicts the locations of six existing groundwater monitoring wells that will be sampled for characterization of the planned construction area. One well (IR78-GW11) is upgradient of the construction area, while the remaining five wells (IR78-GW01, -GW02, -GW04-1, -GW42, and –GW56) are in or downgradient of the construction area.Table 3-2 summarizes the construction details for all six wells, which have been installed to depths of 20 to 29.6 feet to monitor the surficial aquifer system underlying the site.

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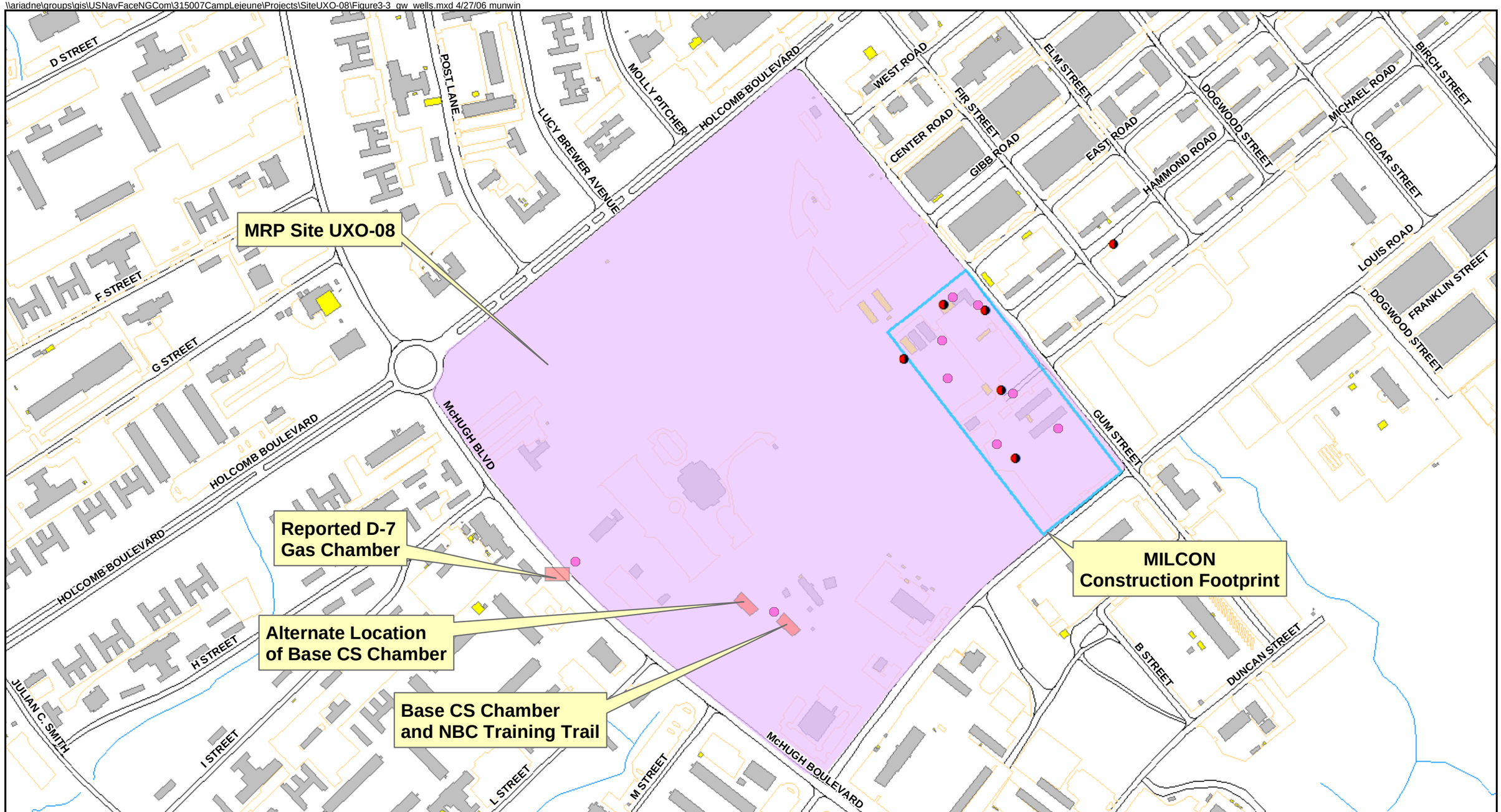


**Legend**

- MRP Site UXO-08
- MILCON Construction Footprint
- Gas Chambers
- Groundwater Monitoring Wells Proposed for PA/SI Sampling
- Surface/Subsurface Soil Sampling Locations
- Surface Soil Sampling Locations
- Buildings
- Vehicle Parking Area
- Road Area

N W E S

0 110 220

Meters

Figure 3-2
Groundwater Monitoring Well and Soil Sampling Locations
MRP Site UXO-08
Camp Lejeune, North Carolina

CH2MHILL

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TABLE 3-2
Groundwater Monitoring Well Construction Details
Site Inspection Work Plan, Site UXO-08, Bazooka Range and Gas Chambers
*MCB Camp Lejeune*
*Jacksonville, North Carolina*

| Well Identification Number | Type | Measuring Point (Top of Casing) Elevation (ft) | Total Depth (ft) | Depth of Screened Interval (ft) | Well Diameter (in) |
|---|---|---|---|---|---|
| IR78-GW11 | Upgradient | 28.22 | 25 | 5 to 25 | 2 |
| IR78-GW42 | Downgradient | 28.52 | 23 | 3.9 to 23.2 | 2 |
| IR78-GW04-1 | Downgradient | 31.63 | 24.5 | 5 to 24.5 | 2 |
| IR78-GW01 | Downgradient | 32.92 | 25 | 5 to 25 | 2 |
| IR78-GW02 | Downgradient | 32.15 | 20 | 5 to 20 | 2 |
| IR78-GW56 | Downgradient | 29.21 | 29.6 | 24.6 to 29.6 | 1 |

Groundwater Elevation Measurements. Groundwater elevations will be measured in each sampled well immediately prior to sampling activities using a decontaminated portable electric water level indicator. Depth will be measured from a reference point at the top of the PVC casing. Upon recording groundwater elevation data, the water level indicator will be lowered to the bottom of each well to record the well's total depth and determine the presence of sediment within each well. All measurements will be made consecutively within a 1-hour time frame and immediately recorded in a dedicated field logbook. These data will also be used to estimate general groundwater flow direction.

Well Purging and Water Quality Measurements. Prior to sampling, each monitoring well will be low-flow purged. During the monitor well low-flow purging, field parameters of groundwater pH, specific conductance, temperature, dissolved oxygen, oxidation-reduction potential, and turbidity will be measured using portable meters calibrated in the field. Groundwater samples will be collected after 1) field parameters have become stable over consecutive readings and at least one well volume has been purged, or 2) at least three well volumes have been purged from the well.

Purge waters will be collected and containerized and managed in accordance with the investigation-derived waste (IDW) management procedures described in Section 3.5.3.

Groundwater Sample Collection and Analysis. One round of groundwater samples will be collected from each of the five wells in accordance with Navy CLEAN SOPs, CH2M HILL SOPs, and the Master Project Plans (CH2M HILL, 2005).

Groundwater samples will be analyzed by a fixed-base laboratory for the following parameters:

- TCL VOCs
- TCL SVOCs
- TCL pesticides and PCBs
- Explosives residues
- Perchlorate

- Total TAL metals and cyanide
- Filtered TAL metals
- TPH

All analytical results will be provided in a Level IV data package and fully validated by a third-party validator, as described in the QC Plan in Section 4 and the Master Project Plans (CH2M HILL, 2005).

## 3.5.2 Analytical Requirements and Sample Handling

### Sample Preservation and Handling

Sample preservation occurs in the field immediately after collection. The containers supplied by the laboratory will contain applicable preservative. This will protect field personnel from transporting, handling, and measuring concentrated acids and bases. QA/QC samples, with the exception of trip blanks, will be collected in the same containers with preservatives as the field samples. The preservative and holding time for each analysis is shown in Table 3-3.

### Quality Assurance and Quality Control

QA/QC requirements for environmental sampling, handling, and management are detailed in Section 4 and in the Master Project Plans (CH2M HILL, 2005). Field QC samples (including trip blanks, field blanks, equipment blanks, duplicate samples, and matrix spike/matrix spike duplicate (MS/MSD) samples) will be collected during the investigation and submitted for laboratory analysis. Required QA/QC samples and the required frequency of collection are as follows:

| Sample Type | Description | Frequency | Analytes |
|---|---|---|---|
| Trip Blank | Designed to detect contamination of environmental samples during transport from the field to the laboratory. A trip blank consists of VOC vials filled with laboratory analyte-free water, transported to the site, handled like a sample, and returned to the laboratory for analysis. Trip blanks must not be opened in the field. | One per every cooler of soil and water samples sent to the laboratory for VOC analysis | VOCs only |
| Field Blank | Designed to detect contamination of environmental samples during transport from the field to the laboratory. A trip blank consists of VOC vials filled with laboratory analyte-free water, transported to the site, handled like a sample, and returned to the laboratory for analysis. Trip blanks must not be opened in the field. | One field blank once a week, or more often if windy or dusty conditions occur. | All laboratory analyses requested for the environmental samples collected at the site for that week |

| Sample Type | Description | Frequency | Analytes |
|---|---|---|---|
| Equipment Blank | Designed to detect contamination of environmental samples caused by contamination of sampling equipment. An equipment blank is analyte-free water that is poured into or pumped through the sampling device, transferred to a sample bottle, and transported to the laboratory for analysis. | One per each day of sampling per type of media utilizing equipment. When disposable equipment is used, one equipment blank is collected near the start of the project to check the cleanliness of the disposable equipment. | All laboratory analyses requested for environmental samples collected with the equipment on that day |
| Field Duplicate | Designed to check precision of data in the laboratory. A field duplicate is a sample collected in addition to the native sample at the same sampling location during the same sampling event. | 10 percent | Same parameters as parent sample |
| MS/MSD | Designed to evaluate potential matrix interferences, accuracy, and precision. Three aliquots of a single sample—one native and two spiked with the same concentration of matrix spike compounds—are analyzed. | 5 percent | Same parameters as parent sample |

Table 3-4 presents the anticipated number of field samples and their associated QA/QC samples.

TABLE 3-3
Analyses, Bottleware, Preservation, and Holding Time Requirements
Site Inspection Work Plan, Site UXO-08, Bazooka Range and Gas Chambers
*MCB Camp Lejeune*
*Jacksonville, North Carolina*

| Media | Analysis | Method | Container | Preservation / Storage | Holding Times |
|---|---|---|---|---|---|
| Soil | TCL VOCs | OLM04 | 2x5-gram + 1x25-gram Encore™ Sampling receptacle | 4ºC | 48 hours |
| | TCL SVOCs | OLM04 | 1x8-oz bottle, Teflon cap | 4ºC | 7 days to extraction, 40 days from extraction to analysis |
| | Explosives Residues | SW-846 8330 | 1x8-oz bottle, Teflon cap | 4ºC | 7 days to extraction, 40 days from extraction to analysis |
| | TCL Pesticides/PCBs | OLM04 | 1x8-oz bottle, Teflon cap | 4ºC | 7 days to extraction, 40 days from extraction to analysis |
| | TAL Metals/Cyanide | ILM05 | 1x4-oz bottle, Teflon cap | 4ºC | 6 months, Cyanide: 14 days, Mercury: 28 days |
| | Total Petroleum Hydrocarbons (full range) | EPA 8015/5030 (GRO)<br>EPA 8015/3550 (DRO)<br>EPA 9071 (Oil & Grease) | 1x4-oz bottle, Teflon cap<br>1x8-oz bottle, Teflon cap | 4ºC | 48 hours |
| | Total Organic Carbon | Lloyd Kahn's Method for TOC in soil | 1x4-oz bottle, Teflon cap | 4ºC | 28 days |
| Groundwater | TCL VOCs | OLC03 | 3x40-mL vials | HCl to pH <2; cool to 4ºC | 14 days |
| | TCL SVOCs | OLC03 | 2x1-L amber jar | 4ºC | 28 days to analysis, nitrate 48 hours |
| | Explosives Residues | SW846 8330 (Prep 3535A) | 2x1-L amber jar | 4ºC | 7 days to extraction, 40 days from extraction to analysis |

TABLE 3-3
Analyses, Bottleware, Preservation, and Holding Time Requirements
Site Inspection Work Plan, Site UXO-08, Bazooka Range and Gas Chambers
*MCB Camp Lejeune*
*Jacksonville, North Carolina*

| | | | | | |
|---|---|---|---|---|---|
| | Perchlorate | EPA 331.0 or EPA 332.0 (dependent on lab capabilities) | 1x1-L amber jar | 4ºC | 7 days to extraction, 40 days from extraction to analysis |
| | TCL Pesticides/PCBs | OLC03 | 3x1-L amber jar | 4ºC | 7 days to extraction, 40 days from extraction to analysis |
| | Total TAL Metals | ILM05 | 1x1-L Poly bottle | $HNO_3$ to pH <2 and cool to 4ºC | 6 months, Mercury: 28 days |
| | Filtered TAL Metals | ILM05 | 1x1-L Poly bottle | $HNO_3$ to pH <2 and cool to 4ºC | 6 months, Mercury: 28 days |
| | Cyanide | ILM5 | 1x1-L Poly bottle | NaOH to pH >12 and cool to 4ºC | 14 days |
| | Total Petroleum Hydrocarbons (full range) | EPA 8015/5030 (GRO)<br>EPA 8015/3550 (DRO)<br>EPA 1664 (Oil & Grease) | 2x40-mL vials<br>2x1-L amber jar | HCl to pH <2;<br>cool to 4ºC<br>4ºC | 14 days<br>48 hours |
| IDW - GW | Full TCLP/RCI | | 6x1-L Poly bottle | 4ºC | Varies |
| IDW - Soil | Full TCLP/RCI | | 1x4-oz. jar<br>2x8-oz. jar | 4ºC | Varies |

Notes
mL = milliliter
oz = ounce
g = gram
TAL = Target Analyte List (TAL) metals
TCL = Target Compound List
VOCs = Volatile Organic Compounds
SVOCs = semivolatile organic compounds
GRO = gas range organics
DRO = diesel range organics
HCL = hydrochloric acid
$HNO_3$ = nitric acid
$H_2SO_4$ = sulfuric acid
NaOH = Sodium Hydroxide
BTEX = Benzene, toluene, ethylbenzene, and total xylenes
MTBE = Methyl tertiary butyl ether
PCBs = polychlorinated biphenyls

TABLE 3-4
Sample Collection Frequencies
Site Inspection Work Plan, Site UXO-08, Bazooka Range and Gas Chambers
*MCB Camp Lejeune*
*Jacksonville, North Carolina*

| Analysis/Test | Sample Matrix | Field Samples | Field Duplicates | Equipment Blanks | Field Blanks | MS/MSDs | Trip Blanks |
|---|---|---|---|---|---|---|---|
| **Direct Push Soil Samples** | | | | | | | |
| TCL VOCs by CLP (OLM04) (with Encore samplers provided by lab) | Solid | 9 | 1 | 2 | 1 | 1 | 2 |
| TCL SVOCs by CLP (OLM04) | | 9 | 1 | 2 | 1 | 1 | |
| TCL Pesticides and PCBs by CLP (OLM04) | | 9 | 1 | 2 | 1 | 1 | |
| Explosives Residues (SW-846 8330) | | 9 | 1 | 2 | 1 | 1 | |
| TAL Metals and Cyanide by CLP (ILM05) | | 9 | 1 | 2 | | 1 | |
| TPH (8015 and 9071) | | 9 | 1 | 2 | 1 | 1 | 2 (GRO Only) |
| Total Organic Carbon (415.2/ 9060) | | 9 | 1 | | | 1 | |
| **Surface Soil Samples** | | | | | | | |
| Explosives Residues (SW-846 8330) | | 20 | 2 | 4 | 1 | 1 | |
| **Monitoring Well Groundwater Samples** | | | | | | | |
| TCL VOCs by CLP (OLM04) without Encore | Aqueous | 6 | 1 | 1 | 1 | 1 | 1 |
| TCL SVOCs by CLP (OLM04) | | 6 | 1 | 1 | 1 | 1 | |
| TCL Pesticides and PCBs by CLP (OLM04) | | 6 | 1 | 1 | 1 | 1 | |
| Explosives Residues (SW-846 8330, Prep 3535A) | | 6 | 1 | 1 | 1 | 1 | |
| Perchlorate - (EPA 331.0 or 332.0) | | 6 | 1 | 1 | 1 | 1 | |
| Total TAL Metals and Cyanide by CLP (ILM05) | | 6 | 1 | 1 | | 1 | |
| Filtered TAL Metals by CLP (ILM05) | | 6 | 1 | 1 | | 1 | |
| TPH (EPA 8015 and 1664) | | 6 | 1 | 1 | 1 | 1 | 1 (GRO Only) |
| **IDW Sampling** | | | | | | | |
| Full TCLP | 1 Aqueous | 2 | | | | | |
| RCI | 1 Soil | 2 | | | | | |

Notes
MS/MSD = Matrix Spike and Matrix Spike Duplicate pair
TCL = Target Compound List
TAL = Target Analyte List
VOCs = Volatile organic compounds
PCBs = Polychlorinated biphenyls
TPH = Total Petroleum Hydrocarbons
SVOCs = Semivolatile organic compounds
Field duplicates are collected at the rate of 1 for every 10 environmental samples
Equipment rinsate blanks are typically collected at the rate of 1 per day per media
Field blanks are typically collected at the rate of 1 per week during sampling
One trip blank is supplied in each cooler submitted to an offsite lab containing VOCs and is analyzed only for VOCs
MS/MSDs are collected at the rate of 1 for every 20 samples
TCLP = Toxicity Characteristic Leaching Procedure
RCI = Reactivity, Corrosivity, and Ignitability Characteristics

## Sample Identification System

The following is a general guide for sample identification; an electronic sample–tracking program will be used to manage the flow of information from the field sampling team to the laboratory and to internal and external data users. The tracking program is used to produce sample labels and COC forms and to manage the entry of sampling-related data, such as station locations and field measurements. The method of sample identification used depends on the type of sample collected and the sample container.

The field analysis data are recorded in field logbooks, along with sample identity information, while in the custody of the sampling team.

Labels for samples sent to a laboratory for analysis will be produced electronically. If they cannot be produced electronically, they must be written in indelible ink. The following information typically is included on the sample label:

- Site name or identifier
- Sample identification number
- Date and time of sample collection
- Sample matrix or matrix identifier
- Type of analyses to be conducted

Each analytical sample will be assigned a unique number of the following format similar to other sample numbers for MCB Camp Lejeune under the Installation Restoration Program:

Site#-Media/Station# or QA/QC-Year/Round or Depth Interval

An explanation of each of these identifiers is given below.

Site#: This investigation includes MRP Site UXO-08 under the MR Program. Therefore, the prefix "MR04" will be used.

Media: GW = Groundwater
SW = Surface water
SS = Surface or subsurface soil
SD = Sediment

Station#: Each monitoring well will be identified with a unique identification number. Existing monitoring well numbers will be used. Soil borings will be numbered consecutively.

QA/QC: D = Duplicate sample (following sample type/number)
FB = Field blank
ER = Equipment rinsate
TB = Trip blank

All MS/MSD samples will be entered in the same line as the field sample on the COC. The total number of sample containers submitted will be entered on the COC and "MS/MSD" will be indicated in the comments section.

Year/Round#: Year/round indicators will be used for samples collected from monitoring wells. Each round of sampling will have a distinct identification number:

"06" will be used for the year 2006
"A" will be used for the first round of samples collected at the site

Depth Interval: Depth indicators will be used for soil and groundwater samples collected using direct push technology. The number will reference the depth interval of the sample:

2–3 = 2 to 3 feet bgs

Under this sample designation format, "MR08-GW01-05A" would mean the following:

| | |
|---|---|
| MR08-GW01-06A | MRP Site UXO-08 |
| MR04-GW01-06A | Groundwater sample from monitoring well #1 |
| MR04-GW01-06A | First sampling event in 2006 |

"MR08-TB1-06A" would mean the following:

| | |
|---|---|
| MR08-TB1-06A | MRP Site UXO-08 |
| MR08-TB1-06A | Trip Blank #1 |
| MR08-TB1-06A | Sampled during the first sampling event in 2006 |

This sample designation format will be followed throughout the project. Required deviations to this format in response to field conditions will be documented.

#### Sample Packaging and Shipping

Samples will be tightly packed in a cooler with bubble wrap packaging material and ice as a preservative. The samples will be either picked up at the site by the analytical laboratory or shipped to the laboratory via overnight courier. The field team leader is responsible for completion of the following forms:

- Sample labels and COC seals
- COC forms
- Appropriate labels and forms required for shipment

Custody of the samples will be maintained and documented at all times. Chain of custody will begin with the collection of the samples in the field and will continue through the analysis of the sample at the analytical laboratory.

### 3.5.3 IDW Management

All IDW generated will be managed during the investigation in accordance with the Master Project Plans (CH2M HILL, 2005). IDW includes liquid waste (e.g., purged groundwater or decontamination fluids) generated during well sampling and equipment decontamination.

## 3.6 Health and Safety Plan

The MCB Camp Lejeune Master Health and Safety Plan (CH2M HILL, 2005) will be utilized along with the project-specific HSP in Appendix B.

Due to the potential presence of MEC at this site, MEC avoidance techniques will be employed for all intrusive activities throughout the field investigation to ensure the safety of

all onsite personnel. Procedures for conducting MEC avoidance are provided in the HSP in Appendix B.

## 3.7 Data Documentation and Processing Procedures

During the SI, three types of data will be generated: field, laboratory, and investigation interpretive. This subsection presents documentation and processing procedures for the data.

### 3.7.1 Field Data

The field team will document all field activities, including any visits to the site by regulatory personnel or their contractors, in a bound field logbook. The logbook will also be used to document, explain, and justify all deviations from the approved work plan and Master Project Plans (CH2M HILL, 2005). Its pages will have water-resistant sizing and will be consecutively numbered. Waterproof ink, preferably black, will be used to record entries in the field logbook. Each page will be dated and signed by the individual making the entry. The field logbook should provide a summary of the field activities.

The sampling team will record in the field logbook sampling information, physical and geological information, and any field measurements (e.g., pH, temperature) taken during sampling. The sample identification system in Section 3.5.2 will be used to identify each sample, in accordance with Camp Lejeune protocol. An identification label will be affixed on each sample container sent to the laboratory.

A copy of all field logbook entries and COC records will be made available upon request.

### 3.7.2 Laboratory Data

Upon their arrival at the laboratory, the samples will be cross-referenced against the COC records. All sample labels will be checked against the COC, and any mislabeling will be identified, investigated, and corrected prior to the sample login at the laboratory when possible. The samples will be logged in at every storage area and work station required by the designated analyses. Individual analysts will verify the completeness and accuracy of the data recorded on the forms.

Raw data will be entered by the analysts in bound laboratory notebooks. A separate book will be maintained for each analytical procedure. All calculations will be entered into designated laboratory notebooks with a sufficient amount of data to compute without reference to other documents. A tracking form will be used to show that at least 10 percent of all calculations have been checked by the analyst and the laboratory QA supervisor from the raw data to the final value stages prior to reporting the results of a group of samples. This tracking form, as well as all logs and calculations, will be made available for any QA audit conducted during the investigation.

Instrument calibration logs and internal quality control procedures will be documented in accordance with the analytical method in use. All proposed analytical methods have been documented in detail in the Master Project Plans (CH2M HILL, 2005) and in Section 3.5. Documentation of these activities will be made available during QA audits.

The reporting requirements will be in accordance with the contract laboratory program (CLP) Statement of Work OLM04.3 for organics analysis and ILM05.2 for inorganics analysis, or other specified analytical method.

Copies of all the analytical data reports, including the QC data, will be maintained by CH2M HILL in the project files.

### 3.7.3 Investigation Results

The results of the SI will be presented in tabular and graphical formats, as well as descriptive and interpretive text. The raw data will be included in a tabular format in appendices of the subsequent investigation report. The following data, as appropriate, will be presented in tables:

- Water level elevations
- Sampling location coordinates
- Comparative data between study areas and background areas

Graphs or figures will be used to depict the following, as appropriate:

- Layout and topography
- Sampling locations
- Boundaries of sampling locations
- Stratigraphy and water level elevations
- Horizontal extent of contamination
- Vertical distribution of contaminants

## 3.8 Project File Requirements

This project will require the administration of a central project file. The data and records management protocols will provide adequate controls and retention of all materials related to the project. Record control will include receipt from external sources, transmittals, transfer to storage and indication of record status. Record retention will include receipt at storage areas, indexing, filing, storage, maintenance, and retrieval.

### 3.8.1 Record Control

All incoming materials related to the project, including sketches, correspondence, authorizations, and logs, shall be forwarded to the PM or designated assistant. These documents will be placed in the project file. Project personnel will work from a copy of the necessary documents. All records shall be legible and easily identifiable.

Examples of the types of records that will be maintained in the project file are:

- Field documents
- Correspondences
- Photographs
- Laboratory data
- Reports
- Procurement agreements

Outgoing project correspondence and reports will be reviewed and signed by the PM.

### 3.8.2 Record Status

To prevent the inadvertent use of obsolete or superseded project-related procedures, the project team members will be responsible for reporting changes in protocol to the CH2M HILL PM. The PM will then inform other members of the Project Team and the Project Quality Assurance Officer of these changes.

Revisions to procedures shall be subject to the same level of review and approval as the original document. The revised document will be distributed to all holders of the original document and discussed with project personnel. Outdated procedures will be marked "void." One copy of a document marked "void," along with the reason(s) for marking the document "void" will be maintained in the project file. In addition, the date a document is marked "void" will be recorded.

### 3.8.3 Record Storage

All project related information will be maintained by CH2M HILL for the duration specified by contract N62470-02-D-3052. Designated personnel will assure that incoming records are legible and in suitable condition for storage. Record storage will be performed in two stages: storage during and immediately following the project, and permanent storage of records directly related to the project.

CH2M HILL will use storage facilities providing a suitable environment, one that will minimize deterioration or damage and prevent loss. Records will be secured in steel file cabinets labeled with the appropriate project identification. CH2M HILL will use Microsoft Excel for data storage. Data will be maintained on CD-ROM and backed up each time a file is edited. Upon presentation of data to MCB Camp Lejeune, a backup of that version will be permanently stored in the central filing location.

At the completion of the project, the PM or his appointed document custodian will be responsible for the project file inventory. All material from the project file, including drawings, project related QA documents, and electronic project documentation and verification records will be maintained by CH2M HILL for the duration specified by contract N62470-02-D-3052.

At the termination of the CLEAN III program, all project files, laboratory data, and reports will be archived and returned to the Navy according to Navy guidance.

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SECTION 4

# Quality Control Plan

## 4.1 Introduction

This QCP describes the QC approach and procedures for the SI at MRP Site UXO-08 and references the MCB Camp Lejeune Master Quality Assurance Project Plan (CH2M HILL, August 2005). The QCP is divided into three parts: Section 4.2 describes the project organization and team member responsibilities, Section 4.3 addresses environmental investigation activities, and Section 4.4 addresses MEC avoidance, surveying, and DGM activities.

The requirements and systems established in this QCP are relevant and applicable to project work performed by CH2M HILL and its subcontractors.

## 4.2 Project Organization and Responsibilities

This section identifies key project team members and lists the QA/QC responsibilities associated with each position and describes communication procedures that will be followed throughout the project. Refer to Section 2.6 for the project schedule summary.

### 4.2.1 Project Team Members

The organizational structure and responsibilities of the project team (refer to Figure 2-1) are designed to provide project QA/QC for the SI at Site UXO-08. Selected positions are described in the following paragraphs.

#### Project Manager

The PM for this project is Thomas M. Roth, P.E. The PM is responsible for overall project activities, including cost control, schedule control, and technical quality. In addition, the PM develops the work plan and monitors task order activities to ensure compliance with project objectives and scope. The PM also communicates with MCB Camp Lejeune and other designated parties regarding project progress.

The PM has ultimate responsibility within the project team for producing deliverables that are technically adequate, satisfactory to the client, and cost-effective. To accomplish this, the PM develops an internal project review schedule, provides written instructions and frequent guidance to the project team, and monitors budgets and schedules. The PM will work with the project team to select an internal QA/QC review team, to coordinate review efforts, to address review comments, and to adjudicate technical issues.

#### Activity Manager

The activity manager (AM) for this project is Matt Louth. The primary objectives of the AM are to build and maintain the relationship with the client and to provide continuity across all projects at MCB Camp Lejeune. The AM will provide overall guidance with regard to

NAVFAC and MCB Camp Lejeune and will serve as the alternate CH2M HILL contact. The AM has overall responsibility for client satisfaction.

### Senior Technical Consultant

The Senior Technical Consultant for this project is Ben Redmond. The Senior Technical Consultant is a company-wide resource with significant experience in the various technical aspects involved in a complex project. The Senior Technical Consultant coordinates all internal QA/QC review for technical validity and adherence to both internal CH2M HILL policy and MCB Camp Lejeune criteria. The Senior Technical Consultant is responsible for evaluating the technical merit of the work planning documents before field activities begin, and reviewing all deliverables before submittal to MCB Camp Lejeune. The Senior Technical Consultant assists the PM in selecting an internal QA/QC review team, coordinating review efforts, addressing review comments, and resolving technical issues.

### Environmental Information Specialist (EIS)

The Environmental Information Specialist (EIS) for this project is Felicia Arroyo. The EIS is responsible for the structure, organization, format, implementation, and operation of the project database as described in the work plan. She provides a point of communication between the laboratory and the project team, supervises the analytical data quality evaluation, and participates in preparing deliverables to the client. The EIS is also responsible for monitoring project-specific laboratory activities, including checking laboratory invoices and reports. She also supervises the data management team and provides direction to the database manager.

### Corporate MR Safety and QC Officer

The Corporate MR Safety & QC Officer for this project is Dan Young. The Corporate MR Safety & QC Officer's responsibilities include, but are not limited to, the following:

- Review and approve the qualifications of proposed UXO staff and UXO subcontractors
- Ensure that the requisite MEC safety records are generated and retained as prescribed in this QCP
- Perform MEC QC audits and surveillance as needed
- Ensure that the responsibilities specific to MR operations are performed by the UXO Technicians.

The Corporate MR Safety & QC Officer will coordinate with the PM and the FTL and has authority to enforce the MEC procedures defined in this QCP. The Corporate MR Safety & QC Officer has the authority to stop work to ensure project activities comply with MEC-related specifications of this QCP, the Contract, and the project. This authority applies equally to all project activities, whether performed by CH2M HILL or its subcontractors.

### Health and Safety Manager (HSM)

The Health and Safety Manager (HSM) for this project is Mike Goldman. The HSM reviews and approves the project-specific HSP as well as subcontractor HSPs. The HSM serves as the point of contact for the Site Safety Coordinator (SSC) for any health- or safety-related issues,

and may conduct project audits. The HSM is also responsible for investigating accidents should any occur during the course of the project.

#### Field Team Leader (FTL) and Site Safety Coordinator (SSC)

The field team leader (FTL) for this project is to be determined. The FTL reports to the PM and is responsible for coordinating field efforts; providing and maintaining sampling equipment and materials; providing shipping and packing materials; and accurately completing the field logbook. The FTL will supervise the completion of all COC records and the proper handling and shipping of samples. As the lead field representative, the FTL is also responsible for consistently implementing program QA/QC measures at the site and for performing field activities in accordance with approved work plans, policies, and field procedures.

The FTL for this project will also serve as the SSC. The SSC develops and implements the project-specific HSP (refer to Appendix B) in the field. The SSC will assist in conducting site briefings and perform all final safety checks. The SSC is responsible for stopping any investigation-related operation that threatens the health and safety of the field team or surrounding populace.

#### Subcontractors

Subcontractors will be used for the investigation at Site UXO-08. The following services will be provided by subcontractors:

- Utility location
- DPT
- Analytical laboratory services
- Data validation
- Geophysical survey
- MEC avoidance services

Procurement of subcontractors will be performed in accordance with the Navy CLEAN Contract Procurement Manual.

### 4.2.2 Project Communication

One of the most critical elements in performing any type of project is to establish and maintain lines of communication among all project personnel. At the beginning of the project or at major milestones, the PM will prepare written project instructions that will be distributed to all team members. These instructions will document project and task instructions, and each team member's responsibility in meeting the objectives, as well as a budget and schedule for successfully executing the work.

Before field activity begins, a project team meeting will be held to review the concept, assumptions, objectives of the field approach, and project objectives. Periodic meetings will be held to review data validity, technical evaluations, major decisions, and overall progress toward completing the project. Additionally, a team kickoff meeting will be held before work on each task is started.

During the field investigation phase of projects, the field teams will meet daily to review the status of the project and to discuss technical and safety issues. When necessary, other

meetings will be scheduled or the FTL will meet individually with field personnel or the subcontractors to resolve problems. During the field effort, the FTL will prepare a weekly report detailing project progress.

During the field effort, the FTL will be in regular telephone or face-to-face contact with the project team. When significant problems or decisions requiring additional authority occur, the FTL can immediately contact the PM for assistance. The EIS, in consultation with the PM and the project chemist (PC), will coordinate communication with the laboratory during sample collection, sample analysis, and data quality evaluation.

Daily and weekly reports, boring logs, QA reports, and other project information will be shared by the members of the project team as needed. All communications with MCB Camp Lejeune will be channeled through the CH2M HILL PM, who will be informed on a daily basis of field activities being conducted.

## 4.3 Environmental Investigation Quality Assurance Objectives

Data Quality Objectives (DQOs) are qualitative and quantitative statements that specify the quality of data required from field and laboratory data collection activities to support decisions concerning risk and remediation. DQOs are established prior to data collection and describe what data are needed, why the data are needed, and how the data will be used to address the problems being investigated. DQOs help to ensure that all data collected are legally and scientifically defensible.

The environmental QC forms (Form 4-1a and Form 4-2a) referenced in this section are provided at the end of the section.

### 4.3.1 Background

An HTW investigation will be performed at the 15-acre MILCON footprint within Site UXO-08, and surface soil samples will be collected across the remainder of the site. Data quality requirements related to the environmental investigation are detailed in the remainder of this Section. Data quality for MEC concerns are addressed in Section 4.4.

### 4.3.2 Levels of Data Quality

Three categories of data will be collected as part of the field effort, and each category has a different level of supporting QA/QC documentation. Level 1 includes field monitoring activities, such as pH, conductivity, temperature, and turbidity. Level 2 includes the analyses associated with the characterization of the IDW samples. All other samples will be submitted to the laboratory for Level 3 analyses. For each QC level, the measures and methods to be used, as well as the applicable data package deliverables, are outlined below.

#### Level 1 – Field Surveys

Level 1 encompasses field monitoring or screening activities and does not require formal data package deliverables. Level 1 activities are focused on easily measured characteristics of a sample such as pH, conductivity, and temperature. The data generated from field surveys are used to make decisions about the execution of the investigation or to provide general sample screening before laboratory analysis.

Monitoring results, as well as pertinent data concerning the sampling event, will be documented in the field logbook. Level 1 documentation will consist of the following:

- Instrument identification
- Calibration information (standards used and results)
- Date and time of calibration and field measurements
- Field measurement results

The logbooks will be reviewed daily by the FTL for completeness and correctness. No additional documentation or data quality evaluation is required.

### Level 2 – IDW Analyses

Level 2 includes the samples submitted to the laboratories for IDW characterization. Samples submitted for analysis under Level 2 will require the delivery of an analytical data package. Level 2 documentation will consist of the following:

- Case narrative
- Sample results
- Selected QC information such as surrogate recovery
- Associated blank results
- Completed COC form and sample receipt information

### Levels 3 and 4 – Laboratory Analyses

The purposes of Levels 3 and 4 data include determining the nature, extent, and potential fate and transport of HTW contamination at the proposed construction footprint at Site UXO-08.

Samples will be analyzed for the constituents presented in Table 3-2. EPA-approved methods from the current edition of publication SW-846, *Test Methods for Evaluating Solid Waste,*[1] will be used to analyze samples where appropriate. Data package deliverables are summarized below.

| **Levels 3 and 4 Data Package Deliverables (Standard Deliverable Package)** |
|---|
| **All Analytical Fractions** |
| Case Narrative |
| Sample ID Cross Reference Sheet (Lab IDs and Client IDs) |
| Completed COC form and any sample receipt information |
| Any analytical/procedural changes (copies of “Confirmation of Communication”) |
| Copies of non-conformance memos and corrective actions |
| **Gas Chromatograph/Mass Spectrometer Organic Analyses** |
| Form 1—Sample Results |
| Form 2—Surrogate Recovery Summary |
| Form 3—MS/MSD Accuracy and Precision Summary |
| Form 4—Method Blank Summary |
| Form 5—Instrument Tuning Summary |

[1] Available at http://www.epa.gov/epaoswer/hazwaste/test/main.htm#table.

| Levels 3 and 4 Data Package Deliverables (Standard Deliverable Package) |
|---|
| Form 6—Initial Calibration Summary |
| Form 7—Continuing Calibration Summary |
| Form 8—Internal Standard Summary |
| **General Chemistry** |
| Includes potentiometric, gravimetric, colorimetric, and titrimetric analytical techniques. The following forms must be included (where applicable) |
| Form 1—Sample Results |
| Form 2A—Initial and Continuing Calibration Summary |
| Form 3—Initial and Continuing Calibration Blanks and Method Blanks Summary |
| Form 5A –MS/MSD Recoveries Summary |
| Form 6—Native Duplicate and MS/MSD Precision Summary |
| Form 7—Laboratory Control Sample Recovery Summary |
| Form 10—Instrument or Method Detection Limit Summary |
| Form 13—Preparation Log Summary |
| **Level 4 only** |
| In addition to all the forms above, Level 4 data packages include all instrument printouts, chromatograms and spectra, bench logs, and any other raw data sufficient for the validator to follow the path of each sample in the analysis process, to examine the chemist's interpretations, and to allow re-calculation or concentrations. |

### 4.3.3 Quality Assurance Objectives for Chemical Data Management

Analytical performance requirements are expressed in terms of precision, accuracy, representativeness, comparability, and completeness (PARCC). Brief definitions for each parameter are presented below.

#### Precision

Precision is a measure of the agreement or repeatability of a set of replicate results obtained from duplicate analyses made under identical conditions. Precision is estimated from analytical data and cannot be measured directly. The precision of a duplicate determination can be expressed as the relative percent difference (RPD).

#### Accuracy

Accuracy is a measure of the agreement between an experimental determination and the true value of the parameter being measured. Accuracy is estimated through the use of known reference materials or matrix spikes. It is calculated from analytical data and is not measured directly. Spiking of reference materials into a sample matrix is the preferred technique because it provides a measure of the matrix effects on analytical accuracy. Accuracy is defined as percent recovery.

#### Representativeness

Representativeness is a qualitative measure of the degree to which sample data accurately and precisely represent a characteristic environmental condition. Representativeness will be assessed by reviewing the presence/absence of contaminants in method blanks, trip blanks, and equipment blanks; sample condition/integrity upon receipt and storage at the

laboratory; and laboratory adherence to sample holding times. In addition, the effects of sample matrix interferences, if any, will be evaluated to determine possible data impact.

#### Comparability

Comparability is another qualitative measure designed to express the confidence with which one data set may be compared to another. Sample collection and handling techniques, sample matrix type, and analytical method all affect comparability. Comparability is limited by the other PARCC parameters because data sets can be compared with confidence only when precision and accuracy are known.

#### Completeness

Completeness is defined as the percentage of valid measurements compared to the total number of measurements made for a specific sample matrix and analysis. The completeness goal for analytical data is 90 percent. All validated data will be used. During the data validation process, an assessment will be made of whether the valid data are sufficient to meet project objectives. If sufficient valid data are not obtained, corrective action will be initiated by the PM.

### 4.3.4 Sampling Procedures

Sampling locations and procedures are discussed in Section 3.

### 4.3.5 Sample Custody

A sample is physical evidence collected from a hazardous waste site, the immediate environment, or another source. Because of the potential evidentiary nature of samples, the possession of samples must be traceable from the time the samples are collected until they are introduced as evidence in enforcement proceedings.

COC procedures are used to maintain and document sample possession for enforcement purposes. The principal documents used to identify samples and to document possession are the following:

- Packing lists
- COC records
- Air bills (such as Federal Express, UPS)
- Field logbooks
- Color photographs of the field activities

Sample custody and COC records will be maintained by the field team until delivered to the laboratory. Sample shipping information from each day will be maintained by the FTL and relayed to the laboratory as soon as possible after sample pickup. These documents could be introduced as evidence should a site investigation result in legal action. To document sample possession, COC procedures are followed.

#### Definition of Custody

A sample is under the field team's custody if one or more of the following criteria are met:

- It is in the field team's possession.

- It is in the field team's view after being in the field team's possession.
- It was in the field team's possession and then the field team locked it up to prevent tampering.
- It is in a designated secure area.

### Field Custody

In collecting samples, the amount collected should be only enough to provide a good representation of the media being sampled. To the extent possible, the quantity and types of samples and sample locations are determined before the actual field work begins.

The following procedures will be used to document, establish, and maintain custody of field samples:

- Labels will be completed for each sample with waterproof ink, making sure that the labels are legible and affixed firmly on the sample container.
- All sample-related information will be recorded in the site logbook.
- The field sampler will retain custody of the samples until they are transferred or properly dispatched.
- To simplify the COC record and minimize potential problems, as few people as possible will handle the samples or physical evidence. One individual from the field sampling team will be designated as the responsible individual for all sample transfer activities. This field investigator will be responsible for the care and custody of the samples until they are properly transferred to another person or facility.
- All samples will be accompanied by a COC record, which documents the transfer of custody of samples from the field investigator to another person, the laboratory, or other organizational elements. Each change of possession must be accompanied by a signature for relinquishment and receipt of the samples.
- Completed COC forms will be placed in a plastic cover, which is then placed inside the shipping container used for sample transport from the field to the laboratory
- When samples are relinquished to a shipping company for transport, the tracking number from the shipping bill or receipt will be recorded on the COC form or in the site logbook.
- Custody seals will be used on the shipping containers when samples are shipped to the laboratory to inhibit sample tampering during transportation.

### Sample Labels

The sampling location identification and sample labeling, handling, and shipping must be performed using standardized and well-documented procedures so that a sample can be tracked to its point of origination. Tracking will be performed from the time of sampling until the analytical data are released from the laboratory. The effectiveness of the tracking process will determine the integrity of the samples. Therefore, a sample-numbering system with a tracking mechanism that allows the retrieval of sample information including

sampling locations, date, time, and analytical parameters must be used. Procedures for this system are provided in Section 3.5.2. The method of sample identification to be used depends on the type of sample collected and container used, as follows:

- Samples collected for in situ field analysis are those collected for specific field analyses or measurements for which the data are recorded directly in the field logbooks or recorded on field data sheets, along with sample identity information, while in the custody of the sampling team. Examples are samples for measurement of field pH, specific conductance, and temperature.
- Samples other than those collected for in situ field measurements or analyses are to be identified on a sample label affixed to the sample container by the FTL. The following information must be included on the label:
  - Laboratory
  - Project name (and number where appropriate)
  - Sample ID
  - Station ID
  - Date (for key to sampling round)
  - Preservation
  - Analysis
  - Sampler's initials, date, and military time

### Chain-of-Custody Record

Samples are accompanied by a COC record, which will contain the information described in the next section.

### Transfer-of-Custody and Shipment

When transferring samples, the individuals relinquishing and receiving the samples will sign, date, and note the time on the COC record. This record documents custody transfer from the sampler to the analyst at the laboratory.

Samples will be packaged properly for shipment and dispatched to the appropriate laboratory for analysis, with a separate COC record accompanying each shipping container. Shipping containers will be sealed with custody seals for shipment to the laboratory. Courier name(s), and other pertinent information, will be entered in the "Received By" section of the COC record.

When samples are split with a facility owner or agency, this information will be noted in the "Sample Remarks" section of the COC record and will be signed by both the sampler and the recipient. If the split is refused, the refusal will be noted and signed by both parties. The "Sample Remarks" section will also indicate if a representative is unavailable or refuses to sign. When appropriate, as in the case of the representative being unavailable, the COC record should contain a statement that the samples were delivered to the designated location at the designated time.

All shipments will be accompanied by the COC record identifying their contents. The original record and yellow copy will accompany the shipment to the laboratory, and the pink copy will be retained by the FTL.

If sent by mail, the package will be registered with return requested. If sent by common carrier, a bill of lading will be used. Freight bills, postal service receipts, and bills of lading will be retained as part of the permanent documentation.

### Laboratory Chain-of-Custody Procedures

When samples are shipped to the laboratory, they will be placed in containers that are sealed on each side with at least one custody seal. A designated sample custodian will accept custody of the shipped samples following the procedure outlined below.

When sample analyses and necessary QA checks have been completed in the laboratory, the unused portion of the sample will be disposed of properly. All identifying stickers, data sheets, and laboratory records will be retained as part of the documentation. Sample containers and remaining samples will be disposed in compliance with all federal, state, and local regulatory requirements.

**Sample Receipt.** A designated sample custodian will accept custody of the shipped samples and verify that the packing list sample numbers match those on the COC record. The custodian will enter pertinent information as to shipment, pickup, and courier in the "Sample Remarks" section of the COC record and enter the sample numbers into a field logbook, which is arranged by project code and station number. Upon receipt of the samples, the custodian will check the original COC and request-for-analysis documents and compare them with the labeled contents of each sample container for corrections and traceability. The sample custodian will sign the COC and record the date and time received. The sample custodian also will assign a unique laboratory sample number to each sample. Cooler temperature (temperature vial) will be checked and recorded.

Care will be exercised to annotate any labeling or descriptive errors. If discrepancies occur in the documentation, the laboratory will immediately contact the FTL as part of the corrective action process (refer to Section 4.3.12). A qualitative assessment of each sample container will be performed to note anomalies, such as broken or leaking bottles. This assessment will be recorded as part of the incoming COC procedure.

**Sample Storage.** The laboratory custodian will use the sample identification number and assign a unique laboratory number to each sample, and is responsible for seeing that all samples are transferred to the proper analyst or stored in the appropriate secure area. The laboratory will send a sample acknowledgement letter to the PM or FTL as a record of the shipment's arrival and the condition of the containers. Any discrepancy will be identified by the laboratory custodian, and corrective actions taken. The PC may need to provide guidance concerning additional actions. A copy of the sample acknowledgement letter will be retained with the COC by the PM.

**Data Recording.** The custodian will distribute samples to the appropriate analysts. Laboratory personnel are responsible for the care and custody of samples from the time they are received until the sample is exhausted or returned to the custodian. The data from sample analyses are recorded on the laboratory report form.

### Documentation Procedures

Field documentation for activities at MCB Camp Lejeune will consist of one or more site-specific field logbooks and any necessary field forms as described in Section 3.7. Each logbook will be identified uniquely by project task and consecutively numbered. For extended field activities, logbooks will be maintained onsite until complete, then stored in the project files.

Photographs will be taken during key field activities.

**Sample Identification.** Sample identification procedures are identified in Section 3.5.2. The sample designation format will be followed throughout the project. Required deviations from this format in response to field conditions will be documented.

**Field Logs.** Field logs will consist of all associated field logbooks and any necessary field forms.

**Site Logbook.**
The site logbook chronicles field investigation activities, but does not have the same level of detail as the field logbook. The site logbook delineates conditions and activities that occur on a given day and references the appropriate field logbooks and forms for specific information. The site logbook also is used to record field changes, along with supporting rationale (refer to Form 4-1, at the end of this section).

The person responsible for the field effort will complete the site logbook. Pages will not be removed from the document. Partially used pages will be lined out, dated, and initialed to prevent data entry at a later date.

The front cover or first page of the site logbook must list the project name, the project number, and dates of use. The following items are to be included, as appropriate to the work scope, in the site logbook:

- Date
- Weather conditions
- List of CH2M HILL personnel, subcontractor personnel, and site visitors by name, title, organization, and purpose, who entered the project area during the day
- Brief descriptions of activities conducted
- Field changes or variances with references to the appropriate documentation of these changes
- Specific comments related to peculiar problems that occurred during the day, if any, and their resolution

Field Logbook.
Information required on the cover of the site logbook also must be provided on the cover of each field logbook. Entries in the field logbook must be continuous through the day. Pages, as well as the logbooks themselves, are numbered consecutively. The following information should be included in the field logbook:

- Date, time of specific activities, and physical location
- Weather conditions
- Names, titles, and organization of personnel onsite, names and titles of visitors, and times of visits
- Field observations, including specific details on sampling activities (including type of sampling, time of sampling, and sample numbers), a description of any field tests and their results, and references to any field forms used and type of document generated
- A detailed description of samples collected and any splits, duplicates, matrix spikes, or blanks that were prepared (A list of sample identification numbers, packaging numbers, and COC record numbers pertinent to each sample or referenced to the appropriate documentation should be noted.)
- Specific problems, including equipment malfunctions and their resolutions
- A list of times, equipment types, and variations of decontamination procedures followed or a reference to the appropriate documentation
- Photograph records

Additional information may be recorded at the discretion of the logbook user. Information to be recorded may include the following:

- Identification of well
- Static water level, depth, and measurement technique
- Presence of immiscible layers and detection methods
- Collection method for immiscible layers and sample identification numbers
- Total depth of well
- Well yield
- Purge volume and pumping rate
- Well purging times and volumes
- Sample withdrawal procedure
- Date and time of collection
- Well sampling sequence
- Types of sample containers and sample identification numbers
- Preservatives used
- Laboratory analyses requested
- Field analysis data and methods
- Sample distribution and transporter

Corrections to Documentation. All original handwritten data recorded in field logbooks, sample identification tags, COC records, and receipts-for-sample forms will be written in

black, waterproof ink. Corrections must be marked with a single line, dated, and initialed. No accountable control documents (such as site, field, and calibration logbooks) are to be destroyed or discarded, even if they are illegible or contain inaccuracies that require a replacement document.

If an error is made on an accountable document assigned to one team member, the FTL may make corrections simply by drawing a single line through the error and entering the correct information. The erroneous information should not be obliterated. Any subsequent error discovered on an accountable document should be corrected by the person who made the entry. All subsequent corrections must be initialed and dated.

Final Evidence File Documentation. Documentation, including voided entries, must be maintained within project files.

### 4.3.6 Calibration Procedures

Field and laboratory equipment must operate satisfactorily within specified operating limits before it can be expected to produce reliable and usable data for a project. Documentation concerning the calibration laboratory equipment should include instrument type, calibration frequency, reference standards used, calibration acceptance criteria, and calibration documentation procedures. Calibration applies to field and laboratory instruments, including balances, refrigerators, and ovens.

Instrument testing is primarily achieved by following the manufacturer's instructions with regard to proper voltages, carrier gas flow rates, temperatures, mass or retention time windows, and certified calibration standards. Practically all instruments come with manufacturer's instructions for initial setup, routine checks, corrective actions, and preventive maintenance.

#### Field Instruments

Field instruments will be calibrated at the beginning of each day using the method described by the manufacturer's instructions and then checked periodically during the day and at the end of the measurement period. Standards used to calibrate the field survey instruments will be traceable to National Institute of Standards and Testing standards. All instrument calibration activities are documented in the field logbooks.

The water quality indicators will be decontaminated before each sample is measured. The probes will be rinsed three times with American Society of Testing and Materials Type II water before storage each day. The meters will be checked for battery charge and physical damage each day. The meters and standard solutions will be stored in a cool, dry environment. Standard solutions will be discarded before they expire.

All field instruments will be set up and operated in strict accordance with the manufacturer's instructions. When the operation of these instruments needs modification because of specific site or sample conditions, such modification will be documented in the instrument logs and field logbooks.

#### Laboratory Equipment

Laboratory instruments will be calibrated in accordance with the manufacturer's directions and applicable method specifications. Laboratory instrument calibration procedures will be summarized in the laboratory's quality assurance plan, which will be reviewed and approved by the PC or designee before samples are submitted for analysis.

### 4.3.7 Analytical Procedures

#### Field Testing and Screening

All field parameters will be analyzed in accordance with SOPs for the individual equipment. Field parameters include temperature, pH, dissolved oxygen, conductance, and oxygen-reduction potential, as discussed in Section 3.

#### Laboratory Methods

The parameters to be analyzed and the specific analytical methods to be used are discussed in Section 3.

### 4.3.8 Data Reduction, Validation, and Reporting

The data quality evaluation process is used to assess the effect of the overall analytical process on the usability of the data.

#### Level 1—Field Survey Data

Field instruments used to collect field survey data (or bulk measurements, such as pH or conductivity) are direct readings, thus making field calculations and subsequent data reduction unnecessary. Field data will be recorded in the site logbooks by appropriately trained field personnel. Field data will include the following:

- Instrument identification
- Calibration information (standards used and results)
- Date and time of calibration and sample measurement
- Sample results
- Supporting information if appropriate

Data will be reviewed by the FTL, who is responsible for the collection and verification of all field data while in the field. Data initially will be accepted or rejected by the FTL before leaving the sampling site. Extreme readings (readings that appear significantly different from other readings at the same site) will be accepted only after the instrument has been checked for malfunction and the readings verified by re-testing.

Field documentation, sample data, instrument calibrations, and QC data will be reviewed by the PM (or a designee) before being included in the project files.

#### Level 2—Screening Analyses

Level 2 data includes the samples submitted to the laboratories for physical parameter testing and IDW characterization. Samples submitted for Level 2 analysis will require the delivery of a limited data package, which includes:

- Case narrative
- Sample results
- Selected QC information, such as surrogate recovery
- Associated blank results
- Completed COC forms and sample receipt information

The PC or designee will review the supporting information and will provide a summary report to the PM at the end of the field effort.

### Level 4 Data Validation

The data quality evaluation process is used to assess the effect of the overall analytical process on the usability of the data. The two major categories of data evaluation are laboratory performance and matrix interferences. Evaluation of laboratory performance is a check for compliance with the method requirements and identifies whether the laboratory did, or did not, analyze the samples within the limits of the analytical method. Evaluation of the matrix interferences is more subtle and involves analysis of several results including surrogate spike recoveries, matrix spike recoveries, and duplicate sample results.

Before the analytical results are released by the laboratory, both the sample and QC data will be reviewed carefully to verify sample identify, instrument calibration, detection limits, dilution factors, numerical computations, accuracy of transcriptions, and chemical interpretations. Additionally, the QC data will be reduced and spike recoveries will be included in control charts, and the resulting data will be reviewed to ascertain whether they are within the laboratory-defined limits for accuracy and precision. Any non-conforming data will be discussed in the data package cover letter and case narrative. The laboratory will retain all of the analytical and QC documentation associated with each data package.

The data package will be reviewed by the validator using the process outlined by the EPA's National Functional Guidelines for organic and inorganic validation (1999, 2004).

For non-CLP methods, the validation will be performed in a process analogous to the National Function Guidelines, but will use QC criteria established by the method.

The data review and validation process is independent of the laboratory's checks; it focuses on the usability of the data to support the project data interpretation and decision-making process. Areas of review include data package completeness, holding time compliance, initial and continuing calibration, spiked sample results, method blank results, and duplicate sample results. Acceptance criteria for each area of review are specified in the analytical method.

Sample results that do not meet the acceptance limit criteria will be indicated with a qualifying flag, which is a one- or two-letter abbreviation that indicates a possible problem with the data. Flags used in the text may include the following:

- U—Undetected. Samples were analyzed for this analyte, but it was not detected above the method detection limit (MDL) or instrument detection limit.
- UJ—Detection limit estimated. Samples were analyzed for this analyte, but the results were qualified as not detected. The results are estimated.

- J—Estimated. The analyte was present, but the reported value may not be accurate or precise.
- R—Rejected. The data are unusable (analyte/compound may or may not be present).

It is important to note that laboratory qualifying flags are included on the data summary forms that are submitted by the laboratory. However, during the data review and validation process, the laboratory qualifying flags are evaluated and replaced with the project-specific validation flags.

Field and Laboratory Blank Contamination. The appearance and concentration of target compounds in field and laboratory blanks as well as environmental samples will be reviewed. Common field sampling and laboratory contaminants detected in blanks include acetone, methylene chloride, and phthalates. Acetone and methylene chloride are used to extract samples in the laboratory, and hence, are common laboratory contaminants. Phthalates (such as bis(2-ethylhexyl)phthalate) are used as plasticizers and are often introduced during sample handling.

If these compounds are encountered in a method blank at a concentration greater than the practical quantification limit (PQL), corrective actions will be taken in an attempt to eliminate these compounds. These compounds may also be detected in field blanks above the PQL. In either case, all analytical data above the PQL associated with these compounds will be flagged to indicate possible cross-contamination.

Surrogate Spike Recoveries. Surrogate spike compounds are added to each sample for the organic analytical methods. Surrogate spike compounds are structurally similar (but not identical) to target compounds and should behave in a similar manner during analysis. Surrogate spike recoveries are used to monitor both laboratory performance and matrix interferences. Surrogate spike recoveries from field and laboratory blanks are used to evaluate laboratory performance because these blanks represent an ideal sample matrix. Surrogate spike recoveries for field samples are used to evaluate the potential for matrix interferences.

When surrogate spike recoveries for field samples fall outside the method target acceptance windows, the samples are re-extracted if appropriate, then re-analyzed. If the surrogate spike recovery is still outside the acceptance window for the re-analyzed sample, then the sample results are qualified as affected by matrix interferences.

Matrix Spike Recoveries. For this QC measure, three aliquots of a single sample are analyzed—one normal and two spiked with the same concentration of matrix spike compounds. Unlike the surrogate spike compounds, matrix spike compounds are found on the method target compound list. Spike recovery is used to evaluate potential matrix interferences, as well as accuracy. The duplicate spike results are compared to evaluate precision.

Laboratory Control Samples. An aliquot of American Society for Testing and Materials Type II water or "Ottawa sand" for organic analyses is spiked with target analytes or compounds at concentrations in the middle of the linear calibration range, and then prepared and analyzed with a batch of samples. The laboratory control sample is used to ensure quality control for each preparation batch.

**Duplicate Sample Results.** Duplicate samples will be collected and submitted for laboratory analysis. Both the native and duplicate samples will be analyzed for the same parameters. Target compounds that are detected in both the native and duplicate samples will be compared and the precision estimated for the sample results calculated.

### 4.3.9 Internal Quality Control

#### Field Measures

Field sampling QC procedures will include collecting trip blanks, field blanks, equipment blanks, field duplicates, and MS/MSD samples, as discussed in Section 3.5.2. These QC samples will be submitted blind to the laboratory. Field measurement QC procedures will include the calibration requirements discussed in Section 4.3.5.

Samples will be collected by personnel wearing Level D personal protection equipment.

#### Routine Analytical Services

Laboratory QC procedures will include the following:

- Analytical methodology according to the specific methods identified
- Instrument calibrations and standards as defined in the specific methods
- Laboratory blank measurements at a minimum frequency of 5 percent or one-per-batch
- Accuracy and precision measurements at a minimum frequency of 5 percent or one-per-set
- Data reduction and reporting according to the specific methods and the specifications outlined in Section 4.3.7
- Laboratory documentation according to the specifications outlined in Section 4.3.7

### 4.3.10 Performance and System Audits

Performance and systems will be audited to verify documentation and implementation of the project-specific QCP, to identify nonconformance, and to verify correction of identified deficiencies.

Assessment activities may include surveillance, inspections, peer review, management system review, readiness review, technical systems audit, performance evaluation, and data quality assessment. The Quality Assurance Control Manager (QACM) will be responsible for initiating audits, selecting the audit team, and overseeing audit implementation.

The QACM, or designee, in consultation with the PM, will evaluate the need for an independent audit. The client may also perform independent project audits. Performance audits are used to quantitatively assess the accuracy of analytical data through the use of performance evaluation and blind check samples. Laboratory performance will be audited by the QACM or designee

### Project Systems Audit

A systems surveillance of operations may be required by the project-specific work plan and would be used to review the total data generation process. This will include onsite review of the field operational system, physical facilities for sampling, and equipment calibrations. Informal document control surveillance will consist of checking each document for completeness, including such items as signatures, dates, and project numbers.

An audit report summarizing the results and corrections will be prepared and entered in the project files.

### Technical Performance Audits

The FTL or a designated representative will conduct an informal surveillance of the field activities. Surveillance for completeness will include the following items:

- Sample labels
- COC records
- Field logbooks
- Sampling operations

The first three items above will be checked for completeness. Sampling operations will be reviewed to determine if they are being performed as stated in Section 3 or as directed by the FTL. A performance surveillance may be conducted by the PM and the FTL during the first week of sampling if it is deemed necessary by the PM, FTL, or client. The surveillance may focus on verifying that proper procedures are followed so that subsequent sample data will be valid. Before the surveillance, a checklist will be prepared by the PM and the FTL to serve as a guide for the performance surveillance. The surveillance may verify the following:

- Collection of samples follows the available written procedures
- COC procedures are followed for traceability of sample origin
- Appropriate QC checks are being made in the field and documented in the field logbook
- Specified equipment is available, calibrated, and in proper working order
- Sampling crews are adequately trained
- Record-keeping procedures are being followed and appropriate documentation is maintained
- Corrective action procedures are followed

An audit report summarizing the results and corrections will be prepared and entered in the project files.

### Field Audits

Field audits are not currently anticipated during this investigation, but will be performed if necessary.

### Laboratory Audits

The analytical laboratory is chosen from among the laboratories in the NAVFAC Atlantic CLEAN III Basic Ordering Agreement, and is one who holds a current Naval Facilities Engineering Service Center approval letter for the analyses requested. The Center conducts audits to ensure laboratories meet the requirements of the Department of Defense Quality Systems Manual for Environmental Laboratories. The manual is based on the National Environmental Laboratory Accreditation Conference's Chapter 5 Quality Systems standard with augmentation to cover Department of Defense environmental programs.

## 4.3.11 Preventive Maintenance

### Field Equipment

The field personnel operating the field equipment and appropriate offsite laboratory chemists are responsible for the maintenance of their respective instruments. Preventive maintenance will be provided on a scheduled basis to minimize down time and the potential interruption of analytical work. All instruments will be maintained in accordance with the manufacturer's recommendations and normal approved laboratory practice.

Scheduled periodic calibration of testing equipment does not relieve field personnel of the responsibility of using properly functioning equipment. If a project team member suspects an equipment malfunction, the device will be removed from service, tagged so that it is not inadvertently used, and the appropriate personnel notified so that a recalibration can be performed or a substitute piece of equipment can be obtained.

### Laboratory Equipment

Designated laboratory personnel will be trained in routine maintenance procedures for all major instrumentation. When repairs become necessary, they will be made by either trained staff or trained service engineers/technicians employed by the instrument manufacturer. The laboratory will have multiple instruments that will serve as backup to minimize the potential for downtime.

Preventive maintenance will be performed according to the procedures delineated in the manufacturer's instrument manuals, including lubrication, source cleaning, detector cleaning, and the frequency of such maintenance. Procedures should be listed in greater detail in the laboratory's quality assurance plan.

Chromatographic carrier gas purification traps, injector liners, and injector septa will be cleaned or replaced on a regular basis. Precision and accuracy data will be examined for trends and excursions beyond control limits to identify evidence of instrument malfunction. Maintenance will be performed when an instrument begins to degrade, as evidenced by the degradation of peak resolution, shift in calibration curves, decrease in sensitivity, or failure to meet one or more of the QC criteria.

Instrument downtime will be minimized by keeping adequate supplies of all expendable items (i.e., an expected lifetime of less than 1 year). Selected items include gas tanks, gasoline filters, syringes, septa, gas chromatograph columns and packing, ferrules, printer paper and ribbons, pump oil, jet separators, open-split interfaces, and mass spectrometer filaments.

### Instrument Maintenance Logbooks

All maintenance will be documented in permanent logs that will be available for review by auditing personnel. Both scheduled and unscheduled maintenance required by operational failures will be recorded. The designated laboratory operations coordinator will review maintenance records regularly to ensure that required maintenance is occurring.

Instrument maintenance logbooks are maintained in laboratories at all times. The logbooks, in general, contain a schedule of maintenance, as well as a complete history of past routine and non-routine maintenance. Laboratories will be audited by the PC prior to the start of analyses.

## 4.3.12 Specific Procedures Used to Assess Data

The final activity of the data quality evaluation is an assessment of whether the data meet the DQOs. The goal of this assessment is to demonstrate that a sufficient number of representative samples were collected and that the resulting analytical data can be used to support the project decision making process.

Data assessment will follow the data review and validation described in Section 4.3.7. The PC or designee will perform data quality evaluation. Once each of the data packages has been reviewed, and the data review worksheets completed, then the entire data set will be evaluated for overall trends in data quality and usability. Information summarized as part of the data quality evaluation may include chemical compound frequencies of detection, dilution factors that might affect data usability, and patterns of target compound distribution. The data set will also be evaluated to identify potential data limitations or uncertainties in the laboratory. An assessment report will be prepared at the end of the project. The report will summarize the findings of the data review/validation as relevant to project usage. Data accuracy, precision, and completeness values will be summarized in the assessment report. The following subsections describe the quantitative definition of accuracy, precision, and completeness.

### Precision

Precision is a measure of the agreement or repeatability of a set of replicate results obtained from duplicate analyses made under identical conditions. Precision is estimated from analytical data and cannot be measured directly. The precision of a duplicate determination can be expressed as the RPD and is calculated as follows:

$$RPD = \{(|X_1 - X_2|)/(X_1 + X_2)/2\} \times 100 = \left\{ \frac{|X_1 - X_2|}{\frac{(X_1 + X_2)}{2}} \right\} \times 100$$

where

$X_1$ = native sample
$X_2$ = duplicate sample

### Accuracy

Accuracy is a measure of the agreement between an experimental determination and the true value of the parameter being measured. Accuracy is estimated through the use of known reference materials or matrix spikes. It is calculated from analytical data and is not measured directly. Spiking of reference materials into a sample matrix is the preferred technique because it provides a measure of the matrix effects on analytical accuracy. Accuracy, defined as percent recovery (P), is calculated as follows:

$$P = \left[ \frac{(SSR - SR)}{SA} \right] x\ 100$$

where:

SSR=spiked sample result
SR=sample result (native)
SA=the spike concentration added to the spiked sample

### Completeness

Completeness is defined as the percentage of measurements judged to be valid compared to the total number of measurements made for a specific sample matrix and analysis. Completeness is calculated using the following formula:

$$\text{Completeness} = \frac{\text{Valid Measurements}}{\text{Total Measurements}} \times 100$$

Experience on similar projects has shown that laboratories typically achieve about 90 percent completeness. All validated data will be used. During the data validation process, an assessment will be made of whether the valid data are sufficient to meet project objectives. If sufficient valid data are not obtained, corrective action will be initiated by the PM.

## 4.3.13 Corrective Actions

### Field Activities

The PM is responsible for initiating corrective actions, which include problem identification, investigation responsibility assignment, investigation, action to eliminate the problem, increased monitoring of the effectiveness of the corrective action, and verification that the problem has been eliminated.

Documentation of the problem is important to the overall management of the study. A corrective action request form for problems associated with sample collection is completed by the person discovering the QA problem (refer to Form 4-2 at the end of this section). This form identifies the problem, establishes possible causes, and designates the person responsible for action. The responsible person will be either the PM or the FTL.

The corrective action request form includes a description of the corrective action planned and has space for follow-up. The PM verifies that the initial action has been taken and appears to be effective, and at an appropriate later date, checks to see if the problem has been resolved fully. The PM receives a copy of all corrective action request forms and enters

them into the corrective action log. This permanent record aids the PM in follow-up and assists in resolving the QA problems.

Examples of corrective action include, but are not limited to, correcting COC forms, analysis reruns (if holding time criteria permit), recalibration with fresh standards, replacement of sources of blank contamination, or additional training in sampling and analysis. Additional approaches may include the following:

- Resampling and reanalyzing
- Evaluating and amending sampling and analytical procedures
- Accepting the data and acknowledging the level of uncertainty or inaccuracy by flagging the validated data and providing an explanation for the qualification

### Laboratory Activities

The laboratory department supervisors review the data generated to verify that all QC samples have been run as specified in the protocol. Laboratory personnel will be alerted that corrective actions may be necessary if the following should occur:

- QC data are outside the warning or acceptable windows for precision and accuracy established for laboratory samples.
- Blanks contain contaminants at concentrations above the levels specified in the laboratory QAP for any target compound.
- Undesirable trends are detected in matrix spike recoveries or RPD between matrix spike duplicates.
- There are unusual changes in detection limits.
- Deficiencies are detected by the laboratory QA Director during internal or external audits, or from the results of performance evaluation samples.

If nonconformances – including, but not limited to, analytical methodologies or QC sample results – are identified by the bench analyst, corrective actions will be implemented immediately. Corrective action procedures will be handled initially at the bench level by the analyst, who will review the preparation or extraction procedure for possible errors and check the instrument calibration, spike and calibration mixes, instrument sensitivity, etc. The analyst will immediately notify his/her supervisor of the problem and the investigation being made. If the problem persists or cannot be identified, the matter will be referred to the laboratory supervisor and QA/QC Officer for further investigation. Once resolved, full documentation of the corrective action procedure will be filed with the laboratory supervisor, and the QA/QC Officer will be provided a corrective action memorandum for inclusion in the project file if data are affected. Corrective actions may include, but are not limited to, the following:

- Re-analyzing suspect samples
- Re-sampling and analyzing new samples
- Evaluating and amending sampling and/or analytical procedures
- Accepting data with an acknowledged level of uncertainty
- Recalibrating analytical instruments

- Qualifying or rejecting the data

Following the implementation of the required corrective action measures, data that are deemed unacceptable may not be accepted by the PM, and follow-up corrective actions may be explored. Details of laboratory corrective actions are provided in the laboratory's quality assurance plan. Corrective action requests will be documented with Form 4-2 (refer to the end of this section).

# 4.4 MEC-Related Quality Assurance Objectives

The MEC-related QC forms (Forms 4-1b through 4-9b) referenced throughout this section are included at the end of the section. In addition to HTW-related objectives, discussed in Section 4.3.1, the purpose of this SI is to evaluate the number and density of anomalies that could potentially represent subsurface MEC and provide geophysical data for future MEC intrusive investigations within Site UXO-08.

## 4.4.1 Definable Features of Work and the Three-Phase Control Process

MEC-related QC will be monitored through the definable features of work (DFOW) using a three-phase control process.

### Definable Features of Work

The DFOWs for this project are divided into activities related to planning, field operations, and final project reports and closeout:

1. **Planning**
   - Pre-Mobilization Activities: System setup for GIS, document management and control, data management and subcontracting
   - Preparing work plan
2. **Field Operations**
   - Site Preparation: mobilization
   - DGM survey
   - Demobilization
3. **Final Project Reports and Closeout**
   - Preparing GIS maps
   - SI Draft and Final Reports: preparing and obtaining approval
   - Data archiving and project closeout

### Three Phases of Control

The Corporate MR Safety & QC Officer is responsible for ensuring that the three-phase control process, including the Preparatory Phase, Initial Phase, and Follow-up Phase, is implemented for each DFOW listed in this QCP, regardless of whether it is performed by CH2M HILL or its subcontractors. Each control phase is important for obtaining a quality product and meeting the project objectives; however, the preparatory and initial audits are

particularly valuable in preventing problems. Production work is not to be performed on a DFOW until successful Preparatory and Initial Phases have been completed.

Preparatory Phase. The Preparatory Phase culminates with the planning and design process leading up to actual field activities. Successful completion of the Preparatory Phase verifies that the project delivery, QC, and safety plans have been completed. The following actions will be performed as applicable for each DFOW:

1. Confirm that the appropriate technical procedures are incorporated into the project work plan and review procedures.
2. Confirm that adequate testing is called for to ensure quality delivery.
3. Confirm definition of preliminary work required at the work site and examine the work area to confirm required preliminary work has been properly completed.
4. Confirm availability of required materials and equipment. Examine materials and equipment to confirm compliance with approved submittals and procedures. Ensure equipment testing procedures are in place, with control limits and frequency, for each piece of equipment.
5. Confirm qualifications/training of personnel and verify roles/responsibilities are well-defined and communicated.
6. Confirm with the HSM that the site HSP adequately address the work operations and that applicable safety requirements have been incorporated into the plan.
7. Discuss methods to be employed during the field activities.
8. Confirm any required permits and other regulatory requirements are met.
9. Verify that lessons learned during previous similar work have been incorporated as appropriate into the project procedures to prevent recurrence of past problems.

Project staff must correct or resolve discrepancies between existing conditions and the approved plans/procedures identified by the PM, Corporate MR Safety & QC Officer, and the team during the Preparatory Phase. The PM or designee must verify that unsatisfactory and nonconforming conditions have been corrected prior to granting approval to begin work.

Results of the activity are to be documented in the Preparatory Inspection Checklist (Form 4-1b) specific for the DFOW and summarized in the Weekly QC Report.

Initial Phase. The Initial Phase occurs at the startup of field activities associated with a specific DFOW. The Initial Phase confirms that this QCP, other applicable work plan sections, and procedures are being effectively implemented and the desired results are being achieved.

During the Initial Phase, the initial segment of the DFOW is observed and inspected to ensure that the work complies with contract and work plan requirements. The Initial Phase should be repeated if acceptable levels of specified quality are not met. The following shall be performed for each DFOW:

1. Establish the quality of work required to properly deliver the project in accordance with contractual requirements. The FTL will ensure that the field teams are aware of expectations associated with the field methods established under the Preparatory Phase by observing the initial work activities and interacting with the PM, AM, and responsible subcontractors' supervisors.
2. Resolve conflicts. The Senior Technical Consultant will guide the PM and responsible supervisor(s) in resolving conflicts. Should conflicts arise in establishing the baseline quality for the DFOW, the responsibility to resolve the conflict falls to the PM. Should the conflict not be resolved in a manner that satisfies the project requirements, the Senior Technical Consultant must elevate the conflict to the program level (i.e., the Program QC Manager) and issue a non-conformance report. The Senior Technical Consultant may direct a cessation of work activity with the concurrence of the Program QC Manager should the issue jeopardize the results of the DFOW or put the project at risk of non-conformance.
3. Verify with the HSM that the site HSP was developed to ensure that the identified hazards adequately address field conditions. Confirm that applicable safety requirements are being implemented during field activities.

Upon completion of Initial Phase activities, the results are to be documented in the Initial Phase Inspection Checklist (Form 4-2b) and the QC logbook and summarized in the Weekly QC Report. Should results be unsatisfactory, the Initial Phase will be rescheduled and performed again.

Follow-up Phase. Completion of the Initial Phase of QC activity leads directly into the Follow-up Phase, which covers the routine day-to-day activities at the site. Inspection and audit activities associated with each DFOW are discussed in Section 4.4.2. Specific concerns associated with the Follow-up Phase include:

1. Inspection of the work activity to ensure work complies with the Contract and work plans.
2. Evaluation and confirmation that the quality of work is being maintained at least at the level established during the Initial Phase.
3. Evaluation and confirmation that required testing is being performed in accordance with procedures established during the Preparatory Phase and confirmed during the Initial Phase.
4. Confirmation that nonconforming work is being corrected promptly and in accordance with the direction provided by the PM, FTL, Senior Technical Consultant, or Corporate MR Safety & QC Officer.

To conduct and document these inspections, the FTL is to generate the Follow-up Phase Inspection Checklist (Form 4-3b). The Follow-up Phase inspections will be performed daily or as otherwise identified in this QCP until the completion of each DFOW.

The FTL is responsible for onsite monitoring of the practices and operations taking place and verifying continued compliance with the specifications and requirements of the Contract, project, and approved project plans and procedures. The FTL is also responsible for verifying that a daily health and safety inspection is performed and documented as

prescribed in the HSP (refer to Appendix B, Attachment B). Discrepancies between site practices and approved plans and procedures are to be resolved and corrective actions for unsatisfactory and nonconforming conditions or practices are to be verified by the UXO Quality Control Specialist (UXOQCS) or a designee prior to granting approval to continue work. Follow-up Phase inspection results are to be documented in the QC logbook and summarized in the Weekly QC Report.

Additional Audits. Additional audits performed on the same DFOW may be required at the discretion of the Program QC Officer, Senior Technical Consultant, Corporate MR Safety & QC Officer, HSM, or the PM. Additional preparatory and initial audits are generally warranted under any of the following conditions: unsatisfactory work, changes in key personnel, resumption of work after a substantial period of inactivity (e.g., 2 weeks or more), or changes to the project scope of work/specifications.

Final Acceptance Audit. Upon conclusion of the DFOW and prior to closeout, the Final Acceptance Inspection must be performed to verify that project requirements relevant to the work are satisfied. Outstanding and nonconforming items are to be documented on the Final Inspection Checklist (Form 4-4b). Resolution of each item must be noted on the checklist. Contractor acceptance and closeout of each definable work feature is a prerequisite to project closeout.

### 4.4.2 Audit Procedures

The Corporate MR Safety & QC Officer is responsible for verifying compliance with this QCP through audits and surveillance. The PM or a designee is to inspect/audit the quality of work being performed for the definable feature of work. The PM or a designee is to verify that procedures conform to applicable specifications stated in this work plan or other applicable guidance. Identified deficiencies are to be communicated to the responsible individual and documented in the QC logbook and Weekly QC Report. Corrective actions are to be verified by the Corporate MR Safety & QC Officer and recorded in the Weekly QC Report.

The specific QC audit procedures for the DFOWs, including the phase during which it is performed, the frequency of performance, the pass/fail criteria, and actions to take if failure occurs, are presented in Table 4-1.

Detailed QC procedures for DGM activities are outlined in the GIP in Appendix C. The QC performed for the DGM activities will be tracked in the Munitions Response Site Information Management System (MRSIMS) (refer to Section 4.4.4) and will be audited by the Project Geophysicist or his designee on a daily basis.

The Inspection Schedule and Tracking Form (Form 4-5b) is to be used by the Corporate MR Safety & QC Officer for planning, scheduling and tracking the progress of audits for this project. The information on the form is to be kept up to date and reviewed by the Corporate MR Safety & QC Officer for planning purposes. Audit activities and corrective actions are to be documented by the Corporate MR Safety & QC Officer in accordance with this chapter. Audit records are to be maintained as part of the project QC file.

## 4.4.3 Corrective/Preventive Action Procedures

The corrective and preventive action procedures are designed to prevent quality problems and to facilitate process improvements, as well as identify, document, and track deficiencies until corrective action has been verified.

### Preventive Measures

While the entire QC program is directed toward problem prevention, certain elements of the program have greater potential to be proactive. The primary tools for problem prevention on this project are discussed in Three Phases of Control (Section 4.4.1), Submittal Management (Section 4.4.5), and Personnel Qualification and Training (Section 4.4.6). Should these preventive measures fail, tracking and communicating deficiencies provide a mechanism for preventing their recurrence.

### Continual Improvement

Project staff at all levels are encouraged to provide recommendations for improvements in established work processes and techniques. The intent is to identify activities that are compliant but can be performed in a more efficient or cost-effective manner. Typical quality improvement recommendations include identifying an existing practice that should be improved and/or recommending an alternate practice that provides a benefit without compromising prescribed standards of quality. Project staff members are to bring their recommendations to the attention of project management or the QC staff through verbal or written means. However, deviations from established protocols are not to be implemented without prior written approval by the PM and concurrence of the Senior UXO Consultant. Where a staff-initiated recommendation results in a tangible benefit to the project, public acknowledgment is to be given by the PM.

### Deficiency Identification and Resolution

While deficiency identification and resolution occurs primarily at the operational level, QC audits provide a backup mechanism to address problems that either are not identified or cannot be resolved at the operational level. Through implementation of the audit program prescribed in this QCP, the QC staff is responsible for verifying that deficiencies are identified, documented as prescribed herein, and corrected in a timely manner. Deficiencies identified by the QC staff are to be corrected by the operational staff and documented by the QC staff.

### Corrective Action Request

A Corrective Action Request (CAR) (Form 4-6b) can be issued by any member of the project staff, including CH2M HILL and subcontractor employees. If the individual issuing the CAR is also responsible for correcting the problem, then that individual should do so and document the results on Part B of the CAR (Form 4-6b). Otherwise, the CAR should be forwarded to the PM, who is then responsible for evaluating the validity of the request, formulating a resolution and prevention strategy, assigning personnel and resources, and specifying and enforcing a schedule for corrective actions. Once a corrective action has been completed, the CAR and supporting information are to be forwarded to the Corporate MR Safety & QC Officer for closure. Sufficient information is to be provided to allow the QC reviewer to verify the effectiveness of the corrective actions.

In addition to observing actual work operations, CARs are to be reviewed during follow-up QC audits. The purposes of this review are as follows: to ensure that established protocols are implemented properly; to verify that corrective action commitments are met; to ensure that corrective actions are effective in resolving problems; to identify trends within and among similar work units; and to facilitate system root cause analysis of larger problems. Particular attention is to be given by the QC staff to work units that generate either an unusually large or unusually small number of CARs.

The PM will determine whether a written Corrective Action Plan (CAP) (Form 4-7b) is necessary, based on whether or not any of the following are met: the CAR priority is high; deficiency requires a rigorous corrective action planning process to identify similar work product or activities affected by the deficiency; or deficiency requires extensive resources and planning to correct the deficiency and to prevent recurrence. The CAP is developed by a PM designee and approved and signed by the PM. The CAP is to indicate whether it is submitted for informational purposes or for review and approval. In either event, the operational staff members are encouraged to discuss the corrective action strategy with the QC staff throughout the process. The CAP form is included at the end of this chapter.

#### Deficiency and Corrective Action Tracking

Each CAR must be given a unique identification number and tracked until corrective actions have been taken and documented in Part B of the form and the CAR is submitted to the PM or a designee for verification and closure.

#### Lessons Learned and Other Documentation

The lessons learned through the deficiency management process are documented on CARs and CAPs. To share the lessons learned, these documents can be submitted to the Client through a Weekly QC Report summarizing the week's QC activities and including a grouping of the Daily QC Reports (Form 4-8b) and all other pertinent reports created during the week.

CARs should be cited in the Weekly QC Report. Minor deficiencies identified during a QC audit that are readily correctable and can be verified in the field are to be documented in the QC logbook and Weekly QC Report without initiating a CAR. Deficiencies that cannot be readily corrected are to be documented by the QC staff on a CAR and in the Weekly QC Report. Copies of CARs are to be referenced in and attached to the Weekly QC Report. CAPs will also be attached to Weekly QC Reports to document the final outcome of the deficiency. Similar or related deficiencies may be addressed on a single CAP.

### 4.4.4 Records Generated

#### Onsite Project File

The FTL will establish and maintain an onsite project file in accordance with the CH2M HILL corporate quality manual for document control. The onsite files will be maintained in the project field office or designated field vehicle. The purpose of these files is to maintain a complete set of all documents, reports, certifications, and other records that provide information on project plans, contractual agreements, and project activities.

The CH2M HILL MRSIMS, which consists of a mobile field data collection device used to collect form-based information of DGM operations and a centralized desktop interface and database, will be the repository for most of the information collected by the field team (e.g., daily reports). This database will contain information that can be easily presented and delivered through automated report production, which reduces the amount of actual paper in the files. The database will be backed-up daily and stored in an offsite location as well as in the project trailer. The files (in either paper or digital format) will include copies of the following:

- Qualifications and training records of all site personnel
- Submittals
- Schedule and progress reports
- Survey records
- Conversation logs
- Meeting minutes and agenda
- Audit logs and schedules
- Photo documentation
- Site maps
- Equipment check records
- Nonconformance and corrective action reports
- Daily work activity summary reports, which may include:
  - Weekly QC Report
  - Daily Health and Safety Report
  - Daily Report (including activity log)
  - Daily DGM Team Logs (Field Data Sheets)
  - Reports on any emergency response actions (EOD will handle emergencies on this project)
  - Equipment check records
  - COC records
  - Incident reports
  - Truck load tickets and shipping papers (if applicable)

As the project activities progress, the FTL will monitor the usefulness of the project filing system for information retrieval. If additional file sections are needed, the FTL will expand the initial filing structure to include additional sections.

### Weekly QC Report

The FTL is responsible for preparing and submitting the Weekly QC Report to the Corporate MR Safety & QC Officer for the project file and providing concurrent courtesy copies to the PM. The Weekly QC Report with attachments is to be submitted to the Program QC Officer on the first workday following the dates covered by the report.

The Weekly QC Report is to provide an overview of QC activities performed each day, including those performed by subcontractors. The QC reports must present an accurate and complete picture of QC activities by reporting both conforming and deficient conditions, and the reports should be precise, factual, legible, and objective. Copies of supporting documentation, such as checklists and surveillance reports, are to be attached.

A field QC log is to be maintained by the FTL to document details of field activities during QC monitoring activities. At the end of each day, copies of the log entries are to be attached to the Weekly QC Report. The information in the field QC log provides backup information and is intended to serve as a phone log and memory aid in the preparation of the Weekly QC Report and for addressing follow-up questions.

QC and health and safety staff input for the Weekly QC Report is to be provided in writing to the FTL at a previously agreed upon time and place, generally no later than 1 hour before normal close of business. For the sake of simplicity and completeness, the format for QC staff input should follow the same format as the Weekly QC Report with only the relevant sections completed.

Copies of Weekly QC Reports with attachments and field QC logs no longer in use are to be maintained in the project QC file. Upon project closeout, all QC logs are to be included in the project QC file.

### 4.4.5 Submittal Management

The PM is responsible for overall management and control of project submittals. The PM is also responsible for submittal scheduling and tracking.

The PM is responsible for ensuring, through detailed review, that submittals as well as the materials and the work they represent, are in full compliance with applicable contractual specifications and the project plans. The PM is also responsible for ensuring that a project file is established and maintained and that accountable project documents are retained and controlled appropriately.

#### Review of Plans and Specifications

During the Preparatory Phase of a DFOW, the PM is responsible for reviewing the plans and, when necessary, requesting clarification from the project team. The primary purpose of this review is to identify and resolve potential conflicts prior to initiating work operations.

#### Review and Approval of Submittals

The Senior Technical Consultant and the PM must review submittals prepared by CH2M HILL and subcontractors for completeness and compliance with the specifications of the project and Contract. Non-compliant submittals are to be returned to the originator for corrective action and re-submittal to the PM or his designee.

Prior to submittal to the Senior Technical Consultant for certification, technical documents (e.g., reports and plans) are to be reviewed by qualified staff. Although part of the QC process, technical reviewers may include, but are not limited to, the QC staff.

For each project document that is submitted for technical review, a Document Review and Release Form (Form 4-9b) is to be initiated by the author, submitted with the document to be reviewed, and used to document and track the review process. A copy of the completed Document Review and Release Form is to be submitted to the PM together with the corrected document for his review and certification. Each document is to provide a signature block for PM and Senior Technical Consultant certification. Original Document

Review and Release Forms, reviewer comments, and annotated versions are to be retained with the deliverable in the project file and reviewed by the QC staff during project audits.

### 4.4.6 Personnel Qualifications and Training

All project staff members will be qualified to perform their assigned jobs in accordance with the terms outlined in the Contract and by the project plans. Specific qualifications and training required for UXO-qualified personnel are stated in the following subsections. Qualifications for DGM operations-related personnel are covered in the GIP in Section 3.4.

#### Documentation of Qualification and Training for UXO-qualified Personnel

The Field Team Leader will maintain records documenting the required qualifications, training, and certifications for each site worker. The FTL will monitor expiration dates to provide advance warning to the PM of when employees will require refresher training or other renewals. The Corporate MR Safety & QC Officer will maintain records of site-specific and routine training for personnel and visitors, as required by these project plans. These records will be maintained onsite for audit purposes.

#### All UXO Personnel

UXO personnel assigned to positions UXO Technician I, UXO Technician II, UXO Technician III, UXO Safety Officer, UXOQCS, or Senior UXO Supervisor, will be qualified and certified in accordance with NAVSEAINST 8020.9B, Ammunition and Explosives Personnel Qualification and Certification Program; terms outlined by U.S. Department of Labor Employment Standards Administration Wage Hour Division for UXO Personnel; and DDESB TP-18, *Minimum Qualifications for Unexploded Ordnance (UXO) Technicians and Personnel*.

#### UXO Sweep Personnel

UXO sweep personnel assist UXO technicians and UXO-qualified personnel in the performance of UXO-related operations. UXO sweep personnel do not have to be UXO technicians; however, they must be provided job and site-specific training. At a minimum, training will include: explosives safety; recognition of MEC, particularly UXO; and the proper use of personal protective equipment. UXO sweep personnel are not involved in the execution of explosives operations and will not have intentional physical contact with MEC. With direction and supervision of UXO-qualified personnel, UXO sweep personnel may:

- Conduct visual and/or detector-aided MEC field search activities.
- Locate subsurface MEC by operating geophysical detection instruments and related equipment.
- Perform field maintenance and tests on geophysical detection instruments and related equipment.
- Remove nonhazardous munitions debris and range-related debris, only after such items have been inspected by a UXO technician or UXO-qualified personnel and determined to be safe for handling.
- Perform site and area security functions.

### UXO Technician I

In addition to being able to perform all functions of the UXO sweep personnel listed in this section, for this project, UXO Technician I personnel may, with the direction and supervision from UXO-qualified personnel:

- Reconnoiter and classify MEC
- Identify all types of military munitions, including possible fuzes and their condition, armed or unarmed; examples are the following:
  - Bombs
  - Guided missiles
  - Projectiles
  - Rockets
  - Land mines and associated components
  - Pyrotechnic items
  - Military explosives and demolition materials
  - Grenades
  - Submunitions
- Operate personnel decontamination stations

### UXO Technician II

In addition to being able to perform all functions of the UXO sweep personnel and UXO Technician I listed in this chapter, for this project, UXO Technician II personnel may:

- Determine precise location in field environment using a variety of techniques such as global positioning equipment or basic land navigation using topographical map and compass
- Perform field-expedient identification procedures to identify contaminated soil
- Perform limited technical supervision of UXO sweep personnel
- Escort personnel who are not directly involved in UXO-related operations (e.g., personnel performing environmental monitoring), but who have activities to perform within exclusion zones
- Inspect material potentially presenting an explosive hazard (MPPEH) for the presence of explosive safety hazards

### UXO Team Composition and Roles

MEC avoidance support will be provided by a two-man UXO team consisting of one UXO Technician II and one team member of UXO Technician I or above.

### Health and Safety Training

Health and safety training requirements for onsite project personnel have been established in accordance with Occupational Safety and Health Act/Occupational Safety and Health Administration requirements for hazardous site workers (29 Code of Federal Regulations

[CFR] 1910.120) and are specified in the HSP (Appendix B). These training requirements must be met before project personnel can begin site work.

### 4.4.7 Testing and Maintenance

Testing and maintenance of equipment such as geophysical instruments, radios, cell phones, vehicles and machinery will be performed per the manufacturer's specifications, this work plan, and all applicable SOPs. Geophysical detection equipment will be tested daily, as specified in the GIP.

Test results must be documented by the individual performing the test. Testing and maintenance records associated with the measuring and testing of equipment must be generated by the individual performing the activity. Documentation for testing and maintenance of equipment is to be made available to the client upon request.

The FTL is responsible for ensuring that the tests are performed and that the results are summarized and provided with the weekly QC report. To track each failing test for future retesting, the failing test must be noted on the deficiency log. Resolution of the failing test is complete when retesting is performed and the corrective action is verified on the deficiency log.

### 4.4.8 DGM Systems Quality Control

An extensive QC program will be applied to the DGM operations at the site. Program elements include DGM instruments quality control, QC seed items, QC of DGM data and deliverables, and analog geophysical systems QC. QC program details are provided in the GIP included as Appendix C.

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SECTION 5

# Environmental Protection Plan

## 5.1 Regional Ecological Summary

MCB Camp Lejeune is located within the headwaters of the New River Watershed. The New River is a slow moving and placid river that was dedicated as a National Scenic River in 1976. The topography along this coastal region is generally flat to gently rolling, which slopes from an altitude of 63 feet above sea level to sea level. Approximately 59 percent of the New River Watershed is forested, with croplands and pastures making up 35 percent and the remaining area being considered urban.

This portion of the North Carolina coast is a diverse region containing over 30 miles of sandy beaches which make up a continuously altering coastline. Many areas of the North Carolina coastline are highly erodible due to the sandy substrate and violent currents. These sandy coastlines transition into a region of pines (*Pinus sp*.), scrub oaks (*Quercus sp*.), sweetgum (*Liquidambar styraciflua*), and dogwood (*Cornus sp*.). Bermuda grass (*Cynodon dactylon*) is the primary undergrowth species of the area. These areas are interspersed with bottomland hardwood forests that were once more prevalent in this region. These forest types are dominated by bald cypress (*Taxodium distichum*), and swamp tupelo (*Nyssa sylvatica var. biflora*), with Atlantic white cedar (*Chamaecyparis thyoides*) being common on organic substrates underlain by sand. Croplands are also common in this area and are predominantly corn, cotton, peanuts, and tobacco.

The climate in Jacksonville, North Carolina, is characterized by short, mild winters and long, hot, humid summers. Average annual net precipitation is approximately 50 inches Ambient air temperatures generally range from 33°F to 53°F in the winter months, and 71°F to 88°F during the summer months.

## 5.2 Endangered/Threatened Species within the Project Site

Many protected species have been sited near and on MCB Camp Lejeune such as the American alligator, the Bachmans sparrow, the black skimmer, the seagreen turtle, the loggerhead sea turtle, the piping plover, the red-cockaded woodpecker, and the rough-leaf loosestrife (North Carolina Ecological Services, 2005). Species that could occur in or adjacent to Camp Lejeune that are listed as threatened, endangered, or of special concern by the U.S. Fish and Wildlife Service (USFWS) under the Endangered Species Act of 1973, as amended are identified in Table 5-1.

Camp Lejeune has active programs in place to protect the three federally protected avian species (American bald eagle, piping plover, and red cockaded woodpecker) that are known to occur on the base. Camp Lejeune worked with the USFWS to establish guidelines for military training in red-cockaded woodpecker cluster sites. Additionally, through Section 7 consultation, the Base implemented measures to properly manage the red-cockaded woodpecker habitats located on base (loblolly pine (*Pinus taeda*) and longleaf (*Pinus*

*palustris*) and pond pine (*Pinus serotina*) areas). Camp Lejeune's red-cockaded woodpecker population has been continually monitored since 1985. Reproductive success, population demographics, and habitat use are recorded annually to help successfully manage the population while facilitating the military use of the land.

A bald eagle's nest is documented on Camp Lejeune. The nest is located at the junction of Sneads Creek and the New River, 5.79 miles from Site UXO-08. Three protective buffers that restrict ground and air-use activities have been established at approximately 750 feet; 1,000 feet; and 1,500 feet from the nest site. It is not within any of these buffer zones.

Suitable habitat for the piping plover does not exist at Site UXO-08. The Atlantic Coast populations of piping plovers tend to prefer sandy beaches close to the primary dune of barrier islands and coastlines. They prefer sparsely vegetated open sand, gravel, or cobble for a nest site. They forage along the rack line where the tide washes up onto the beach. As such, it is unlikely that piping plovers are located on or adjacent to Site UXO-08. Since Site UXO-08is not located along the Atlantic Ocean coastline and does not contain suitable habitat, piping plovers are not expected to be present at the site for any reason (feeding, breeding, nesting).

Site UXO-08 is approximately 0.64 mile from the Atlantic Coast. The federally protected marine species (e.g., green sea turtle, leatherback sea turtle, loggerhead sea turtle, and West Indian manatee) listed in Table 5-1 are, however, unlikely to inhabit the heavy use area characterizing Site UXO-08. Site UXO-08supports a high level of human activity including administrative and industrial uses and mowing of open areas. Additionally, site activities in support of this work plan are limited to a small number of soil and groundwater samples and geophysical surveying. SI work activities are not likely to impact these species.

The eastern cougar is the only federally listed mammal species that could be in Onslow County. Suitable habitat for the eastern cougar does not exist at Site UXO-08 and the level of human activity would tend to make the species avoid the area. The only extant population of eastern cougar is located in south Florida. Because the eastern cougar has not been verified in the area in more than 50 years and there is substantial human activity in proximity to Site UXO-08, it is very unlikely that the eastern cougar would occur on the site and no impacts are expected.

Two of the four federally listed plant species have been identified on the base: rough-leaved loosestrife and seabeach amaranth. Approximately 22 rough-leaved loosestrife sites are found on Camp Lejeune with 76 acres buffered and marked to protect this species. Rough-leaved loosestrife sites are visited annually to visually inspect for changes in extent and apparent health. Approximately half of the rough-leaved loosestrife sites occur within protected red-cockaded woodpecker sites, obviating the need for marking each of these sites individually. This significantly lessens the amount of encumbered area by restrictions involving the plants. The other sites, mostly falling within the Greater Sandy Run Area are marked with white paint around a perimeter that extends 100 feet from the outermost individuals. None of these sites are located on or adjacent to Site UXO-08.

Seabeach amaranth is an annual that has been described as a dune-builder because it frequently occupies areas seaward of primary dunes often growing closer to the high tide

line than any other coastal plant. As such, this plant is generally found along Oslow Beach and thus is not located on or adjacent to Site UXO-08.

No adverse impacts to listed species are expected to result from the proposed work at Site UXO-08. Project design features have been developed to prevent impacts to listed species.

## 5.3 Wetlands within the Project Site

No wetlands are known to be located at Site UXO-08. Therefore, no direct impacts to wetlands will result from the project. No soil disturbance is anticipated from planned site work as described in this Work Plan. No wetlands on or downstream of Site UXO-08 are expected to be impacted by the project.

## 5.4 Cultural and Archaeological Resources within the Project Site

Due to the high degree of land disturbance in the project work area, the probability that significant cultural or archaeological resources are located within the project area is minimal. Additionally, the environmental sampling and DGM activities proposed to support this work plan involve only a limited degree of intrusive activity. The probability that any significant cultural or archeological resources will be impacted by the field investigation is low. If any new cultural or archaeological materials or resources are discovered within the project area, a qualified archaeologist will be notified to provide guidance on performing further work in the area.

## 5.5 Water Resources within the Project Site

As shown in Figures 1-1 and 1-2, Site UXO-08 does not encompass nor is it bounded or bordered by surface water sources. No water resources are expected to be impacted by the project.

## 5.6 Coastal Zones within the Project Site

Onslow County is subject to the rules and policies of the North Carolina Coastal Resources Commission, which administers the Coastal Area Management Act (CAMA). The CAMA requires permits for development in Areas of Environmental Concern (AEC) if it meets all of the following conditions:

- It is in one of the 20 counties covered by CAMA.
- It is considered "development" under CAMA.
- It is in, or it affects, an Area of Environmental Concern established by the Coastal Resources Commission.
- It doesn't qualify for an exemption.

"Development" includes activities such as dredging or filling coastal wetlands or waters, and construction of marinas, piers, docks, bulkheads, oceanfront structures and roads.

The SI at Site UXO-08 will include surface investigations and the collection of subsurface soil samples using direct-push technology. These activities do not fit the definition of "development" under CAMA; therefore, a CAMA permit is not necessary for this project.

## 5.7 Trees and Shrubs to be removed within the Project Site

No vegetation removal is anticipated in association with the field investigations described in this Work Plan. The base will coordinate with the Environmental Management Division office to identify any federally protected species or archeological sites that may be encountered during the contractor's work. Any Federally listed plant species will be identified and left in place.

## 5.8 Existing Waste Disposal Sites within the Project Site

No waste disposal sites are present at Site UXO-08.

## 5.9 Compliance with Applicable or Relevant and Appropriate Requirements

CH2M HILL will follow all applicable regulations concerning environmental protection, pollution control, and abatement for the proposed project work. No permits have been determined to be required for the proposed work. Table 5-2 lists the applicable or relevant and appropriate requirements (ARARs) for environmental protection.

## 5.10 Detailed Procedures and Methods to Protect and/or Mitigate the Resources/Sites Identified

Prior to initiation of the proposed work, a general survey of the project area will be conducted by a qualified ecologist to identify any obvious environmental concerns. The ecologist, in conjunction with the PM, will provide instructions to field personnel regarding the protection of onsite environmental resources. Such protective measures will include, but are not limited to, the following:

- Should any federally protected plant be identified within the project area, the specimens will be flagged for easy relocation and verification.
- Should any cultural or archaeological material or resource be discovered within the project area, a qualified archaeologist will be notified to provide guidance on performing further work in the area.
- The PM will seek the guidance of the qualified ecologist to determine appropriate mitigation measures in the event that the performed work activities impact any environmental resource.

TABLE 5-1
Species Potentially Occurring on or Adjacent to Camp Lejeune Listed as Threatened, Endangered, or of Special Concern by the USFWS

| Scientific Name | Common Name | Federal Status | Habitat |
|---|---|---|---|
| *Chelonia mydas* | Green sea turtle | T | Green turtles are generally found in fairly shallow waters (except when migrating) inside reefs, bays, and inlets. The turtles are attracted to lagoons and shoals with an abundance of marine grass and algae. Open beaches with a sloping platform and minimal disturbance are required for nesting. |
| *Caretta caretta* | Loggerhead sea turtle | T | The loggerhead is widely distributed within its range. It may be found hundreds of miles out to sea, as well as in inshore areas such as bays, lagoons, salt marshes, creeks, ship channels, and the mouths of large rivers. |
| *Dermochelys coriacea* | Leatherback sea turtle | E | An open ocean species, it sometimes moves into shallow bays, estuaries and even river mouths. |
| *Trichechus manatus* | West Indian Manatee | E | Manatees inhabit both salt and fresh water of sufficient depth (1.5 meters to usually less than 6 meters) throughout their range. |
| *Alligator mississippiensis* | American alligator | T(S/A) | Rivers, swamps, estuaries, lakes, and marshes |
| *Charadrius melodus* | piping plover | T | Open, sandy beaches close to the primary dune of the barrier islands and coastlines of the Atlantic for breeding. They prefer sparsely vegetated open sand, gravel, or cobble for a nest site. They forage along the rack line where the tide washes up onto the beach. |
| *Aimophila aestivalis* | Bachman's sparrow | FSC | Occurs only in pine forests of the southeastern U.S. |
| *Haliaetus leucocephalus* | American bald eagle | T | A single bald eagle's nest is found on Camp Lejeune- at the junction of Sneads Creek and the New River near the back gate. Three protective buffers have been established at approximately 750', 1000', and 1500' from the nest site. |
| *Laterallus jamaicensis* | Black rail | FSC | Marsh/wetlands; The "Eastern" Black Rail can be found in appropriate saltmarsh habitat along the eastern seaboard from Connecticut to Florida and along the Gulf Coast. |
| *Rana capito capito* | Carolina gopher frog | FSC | Carolina Gopher Frogs live primarily in the sandhills and pine barrens of the North Carolina Coastal Plain. Gopher Frogs are more terrestrial than most frogs, generally only coming to the water to breed. They are also nocturnal, spending daylight hours underground in burrows. |
| *Puma concolor couguar* | Eastern cougar | E | No preference for specific habitat types has been noted. The primary need is apparently for a large wilderness area with an adequate food supply. Male cougars of other subspecies have been observed to occupy a range of 25 or more square miles, and females from 5 to 20 square miles. |

TABLE 5-1
Species Potentially Occurring on or Adjacent to Camp Lejeune Listed as Threatened, Endangered, or of Special Concern by the USFWS

| Scientific Name | Common Name | Federal Status | Habitat |
|---|---|---|---|
| *Passerina ciris ciris* | Eastern painted bunting | FSC* | Found mainly in southern states and Mexico, where the brushy, weedy shrub-scrub habitat that this bird prefers abound |
| *Ammodramus henslowii* | Eastern Henslow's sparrow | FSC | A species of tallgrass prairies, agricultural grasslands, and pine savannas of the eastern U.S.; the species migrates south to spend the non-breeding season in the native pine savanna habitats of the southeastern U.S. |
| *Ophisaurus mimicus* | Mimic glass lizard | FSC | This species is found in the southeastern Coastal Plain. They are most common in pine flatwoods and open woodlands. |
| *Picoides borealis* | Red-cockaded Woodpecker | E | For nesting/roosting habitat, open stands of pine containing trees 60 years old and older. Red-cockaded woodpeckers need live, large older pines in which to excavate their cavities. Longleaf pines (Pinus palustris) are most commonly used, but other species of southern pine are also acceptable. Dense stands (stands that are primarily hardwoods, or that have a dense hardwood understory) are avoided. Foraging habitat is provided in pine and pine hardwood stands 30 years old or older with foraging preference for pine trees 10 inches or larger in diameter. In good, moderately-stocked, pine habitat, sufficient foraging substrate can be provided on 80 to 125 acres. |
| *Heterodon simus* | Southern hognose snake | FSC | These snakes are found in sandy fields and woods of the Coastal Plain, particularly in the Sandhills region. |
| *Procambarus plumimanus* | Croatan crayfish | FSC | Carteret, Craven, Duplin, and Jones counties, North Carolina. Temporary ponds, pools, and burrows (secondary burrower). |
| *Isoetes microvela* | A quillwort | FSC | Quillwort are usually restricted to areas of clean water where other plants are absent. Occasionally, quilwort may grow partly or entirely out of the water. |
| *Rhexia aristosa* | Awned meadowbeauty | FSC | found in a variety of wet habitats in the Coastal Plain from New Jersey to Alabama |
| *Lobelia boykinii* | Boykin's lobelia | FSC | grows in swamps and cypress ponds from the coastal plain of Delaware to Florida. The lower portion is often immersed in water, at least seasonally. |
| *Tofieldia glabra* | Carolina asphodel | FSC | Savannas, sandhill seeps, moist sandhill/pocosin ecotones |
| *Solidago pulchra* | Carolina goldenrod | FSC | Bogs, freshwater habitats, grasslands |
| *Parnassia caroliniana* | Carolina grass-of-parnassus | FSC | Bogs, freshwater habitats, grasslands |

TABLE 5-1
Species Potentially Occurring on or Adjacent to Camp Lejeune Listed as Threatened, Endangered, or of Special Concern by the USFWS

| Scientific Name | Common Name | Federal Status | Habitat |
|---|---|---|---|
| *Asplenium heteroresiliens* | Carolina spleenwort | FSC | Rock outcrops |
| *Carex chapmanii* | Chapman's sedge | FSC | Grasslands, pinelands |
| *Rhynchospora pleiantha* | Coastal beaksedge | FSC | extremely rare, found at fewer than 25 sites throughout its North Carolina-to-Alabama range |
| *Solidago villosicarpa* | Coastal Goldenrod | FSC | Known to occur in only 5 populations in three counties in eastern North Carolina. Three of these populations occur on Camp Lejeune. The other sites occur in Pender and Brunswick Counties. Currently the North Carolina Natural Heritage Program is conducting a survey of likely habitat to look for coastal goldenrod. |
| *Thalictrum cooleyi* | Cooley's meadowrue | E | Cooley's meadowrue occurs in moist to wet bogs and savannahs. It grows along fireplow lines, roadside ditches, woodland clearings, and powerline rights-of-way, and needs some type of disturbance to maintain its open habitat. |
| *Carex lutea* | Golden sedge | E | Biologists have located golden sedge in only eight locations, all in coastal savannas in Onslow and Pender Counties that are underlain by calcareous, or chalk, deposits. |
| *Dichanthelium sp.* | Hirst's panic grass | FSC | Worldwide, Hirst's panic grass occurs in four extant populations. Historically, it was found in coastal plain habitats in the states of New Jersey, Delaware, North Carolina and Georgia. Currently Hirst's panic grass is known to exist in one site in Delaware and two known sites in North Carolina, both of which are on Camp Lejeune. |
| *Myriophyllum laxum* | Loose watermilfoil | FSC | Riparian habitats |
| *Calopogon multiflorus* | Many-flower grass-pink | FSC | Grasslands, pinelands; typically in wet areas |
| *Litsea aestivalis* | Pondspice | FSC | Freshwater habitats |
| *Lysimachia asperulaefolia* | Rough-leaved loosestrife | E | Species generally occurs in the ecotones or edges between longleaf pine uplands and pond pine pocosins (areas of dense shrub and vine growth usually on a wet, peaty, poorly drained soil), on moist to seasonally saturated sands and on shallow organic soils overlaying sand. Rough-leaved loosestrife has also been found on deep peat in the low shrub community of large Carolina bays |
| *Amaranthus pumilus* | Seabeach amaranth | T | Occurs on barrier island beaches |

TABLE 5-1
Species Potentially Occurring on or Adjacent to Camp Lejeune Listed as Threatened, Endangered, or of Special Concern by the USFWS

| Scientific Name | Common Name | Federal Status | Habitat |
|---|---|---|---|
| *Solidago verna* | Spring-flowering goldenrod | FSC | The only spring-flowering goldenrod that occurs in the Sandhills and Coastal Plain of the Carolinas. It can be found in a wide array of habitats, including pine savannas, pocosins, and pine barrens |
| *Rhynchospora thornei* | Thorne's beaksedge | FSC | Bogs, freshwater habitats, pinelands |
| *Dionea muscipula* | Venus flytrap | FSC | Bogs, pinelands |

E = Endangered—A taxon in danger of extinction throughout all or a significant portion of its range.
T = Threatened—A taxon likely to become endangered within the foreseeable future throughout all or a significant portion of its range.
FSC = Federal species of special concern—species may or may not be listed in the future.
T(S/A)—Threatened due to similarity of appearance (e.g., American alligator )--a species that is threatened due to similarity of appearance with other rare species and is listed for its protection. These species are not biologically endangered or threatened and are not subject to Section 7 consultation.
*Historic record—the species was last observed in the county more than 50 years ago.

TABLE 5-2
Applicable or Relevant and Appropriate Requirements for Environmental Protection
*SI Work Plan, Site UXO-08, Bazooka Range and Gas Chambers*

| Reference | Title |
|---|---|
| **Federal Requirements** | |
| 33 USC 1251, et seq. | Clean Water Act |
| 33 USC 403 | Rivers and Harbors Act of 1899 |
| 16 USC 1531 et seq., per 50 CFR 402 | Endangered Species Act |
| 16 USC 703, et seq. | Migratory Bird Treaty Act |
| 16 USC 470 | National Historic Preservation Act of 1966 |
| 16 USC 469, et seq., and 36 CFR 65 | National Archaeological and Historic Preservation Act |
| **State Requirements** | |
| 15A NCAC 7H | Guidelines for areas of environmental concern. |
| GS 113-331 to 133-337 | North Carolina Endangered Species Act |

USC = U.S. Code; NCAC = North Carolina Administrative Code

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SECTION 6

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# Appendix A
# Archival Records Research Report

**Final**

# Archival Records Search Report

## MRP Site UXO-08
## Former Bazooka Range and Gas Chambers
## MCB Camp Lejeune, NC

**Contract Task Order 109**
**October 2006**

Prepared for

**Department of the Navy**
**Atlantic Division**
**Naval Facilities Engineering Command**

Under the

**LANTDIV CLEAN III Program**
**Contract N62470-02-D-3052**

**Prepared by**


**Herndon, Virginia**

# Contents

# Acronyms and Abbreviations

| | |
|---|---|
| °F | degrees Fahrenheit |
| asl | above sea level |
| CCC | Civilian Conservation Corps |
| CS | ortho-chlorobenzylidene malononitrile, or tear gas |
| CTO | Contract Task Order |
| DMM | Discarded Military Munitions |
| EOD | Explosive Ordnance Disposal |
| ESI | Expanded Site Investigation |
| HTW | hazardous and toxic wastes |
| LANTDIV | Atlantic Division |
| msl | mean sea level |
| MCB | Marine Corps Base |
| MEC | munitions of explosive concern |
| NARA | National Archives and Records Administration |
| NAVFAC | Naval Facilities Engineering Command |
| NBC | Nuclear, Biological, and Chemical |
| NMFRL | Naval Medical Field Research Laboratory |
| OU | Operable Unit |
| RI | Remedial Investigation |
| Rte | Route |
| SI | Site Inspection |
| TNT | 2,4,6-trinitrotoluene |
| UST | underground storage tank |
| UXO | unexploded ordnance |
| WWII | World War II |

**SECTION 1**

# Introduction, Purpose, and Scope

A Site Inspection (SI) and Construction Support are planned for a suspected former bazooka range and former gas chamber locations located in the Parade Ground area at Marine Corps Base (MCB) Camp Lejeune, North Carolina. The work is being conducted under the Navy CLEAN III Contract N62470-02-D-3052, Contract Task Order (CTO) 109, for the Naval Facilities Engineering Command (NAVFAC), Atlantic Division (LANTDIV).

The purpose of the SI is to evaluate the potential presence of munitions and explosives of concern (MEC) and hazardous and toxic substances (HTW) at the site. The purpose of the construction support is to identify and remove any MEC that may be present in a planned 15-acre military construction (MILCON) area in the suspected former bazooka range. To support the SI effort, this archival records search report has been prepared to provide a narrative of the historical activities at the project area that may have resulted in environmental contamination with MEC and/or HTW.

The archival records search report is an investigative review of existing information about the site and its surrounding area, with an emphasis on obtaining information from personnel and historical resources that might indicate a potentially hazardous release to the environment, specifically MEC or HTW. The scope of the report includes:

- A review of existing information about the site (including MCB Camp Lejuene maps, drawings, and reports, and interviews with MCB Camp Lejuene personnel).
- A site and environs reconnaissance.
- Collection of additional information about the site.

A complete listing of resources identified and investigated for this report is provided in Attachment 1. Attachment 1 also includes details concerning the reviews of the historical information from the Marine Corp Library, National Archives and Records Administration (NARA) map and text files, and Camp Lejeune base files. Attachment 2 contains photographs obtained during the research activities.

SECTION 2

# Background Information

## 2.1 Facility Information

MCB Camp Lejeune is located on the Atlantic coast in Jacksonville, North Carolina (refer to Figure A-1). The city of Jacksonville in Onslow County is the principal support community for the base. MCB Camp Lejeune occupies 153,439 acres including more than 450 miles of roads, 6,946 buildings, and facilities 14 miles of beach on the Atlantic Ocean for amphibious training (Department of the Navy, July 2005, OCS Website, 2005). Originally established in 1941, the base is home to Marine Expeditionary Force units and includes six major Marine Corps commands, two Navy commands, one Coast Guard command, and is home to several Marine Corps Formal schools. MCB Camp Lejeune supports a total population of approximately 138,000 people, to include 37,221 active duty military and 53,614 military dependents. In addition, the base employs 4,883 civilian employees and supports 42,562 military retirees and their dependents located in the region (Department of the Navy, July 2005). The base is bisected by the New River. The Parade Ground is situated in the east central portion of the base, just east of Hadnot Point, along Holcomb Boulevard (refer to Figure A-1).

### 2.1.1 Site Conditions and Current Operations

The Parade Ground, officially designated as W.P.T. Hill Field, is located in the Hadnot Point area of the base, along the eastern side of Holcomb Boulevard between Gum Street and McHugh Boulevard (refer to Figure A-2). It is an expansive lawn in the central part of the base for ceremonies, receptions, parades, and other formal assemblies. **I**t also hosts community gatherings, open-air concerts, including those by Camp Lejeune's 2nd Marine Division Band, and athletic activities. W.P.T. Hill Field frequently serves as a helicopter landing zone for both administrative and tactical helicopter lifts. (Camp Lejeune website, 2005). The field is surrounded on all four sides by industrial and administrative areas of the base. The land is flat and the majority of the property has been cleared of trees, though some forested areas remain in the eastern third of the property.

### 2.1.2 Climate and Meteorology

The climate in the MCB Camp Lejeune area is characterized by mild winters and hot humid summers. Winters are usually short and mild with occasional and short duration cold periods. Summers are long, hot, and humid. Average annual net precipitation is approximately 50 inches. Ambient air temperatures generally range from 33 degrees to 53 degrees Fahrenheit (°F) in the winter months, and 71°F to 88°F during the summer months. Winds are generally south-southwesterly in the summer, and north-northwesterly in the winter (Water and Air Research, 1983). The hurricane season in the immediate area surrounding MCB Camp Lejeune begins on June 1 and continues through

November 30. Storms of non-tropical origins such as frontal passages, local thunderstorms, and tornadoes are more frequent and can occur year-round.

### 2.1.3 Topography, Geology and Hydrology

The aesthetic environment in and around the Parade Ground is characterized by flat topography with minimal slopes. The area is essentially an open field situated among the main industrial and administrative area of the base.

The land surface at MCB Camp Lejeune has been alternately exposed and submerged over time by water and marine deposits from an ancient inland sea. These deposits were laid down to form the weakly dissected alluvial plane. The deposits are mostly sands layered with clay and marine shells. Elevations range from 0 feet above sea level (asl) at the waterways to 72 feet asl between the New River and US Rte 17. MCB Camp Lejeune consists of both broad, level flatlands and gently rolling hills. The land within the Hadnot Point industrial area (including the Parade Ground) is relatively flat with surface elevations ranging between 22 to 32 feet above mean sea level (msl) (Baker, 1994).

Nearly 30 percent of the soils at MCB Camp Lejeune are considered hydric. Leon fine sand, Mukalee Loam, and Murville fine sand are the most common hydric soils. Baymeade fine sand, a non-hydric soil, is the most prevalent soil type at the installation and encompasses 18 percent of the land (Department of the Navy, July 2005).

A soil survey for Onslow County indicates that the Baymead Foreston Stallings soil association is predominant in the Camp Johnson portion of Camp Lejeune. This association is typically found on level to gently sloping areas and ranges from somewhat poorly to well-drained with loamy subsoil throughout. Four soil map units are mapped in the study area. They are: Baymeade-Urban Complex, 0 to 6 percent slopes (BmB), Baymeade fine sand 0 to 6 percent slopes (BaB), Wando fine sand 1 to 6 percent slopes (WaB), and Craven fine sandy loam (CrC), 4 to 8 percent slopes. The affected soil map units have not been classified either as hydric soils or prime farmland by the Natural Resources Conservation Service (MCB Camp Lejeune, July 2002). Most soils within this area have been previously disturbed due to a history of intensive use.

Natural drainage has been altered by the installation of drainage ditches, storm sewers, buildings, and extensive paving. Surface runoff not intercepted by a manmade structure from southern portions of the site appears to drain into Cogdels Creek from an unnamed tributary (Baker, 1994). Cogdels Creek then drains into the New River.

## 2.2 Ownership and Operational History

### 2.2.1 Ownership History

The history of the land now occupied by Camp Lejeune is documented primarily through land records and maps. Following the start of World War II (WWII), the War Department began purchasing tracts of land in 1941 from local residents to meet the need for an East Coast amphibious training facility. Prior to the Marines occupation, the land had been occupied by white and African-American communities and farms since the Colonial era.

The land contained plantation houses, cabins, farm buildings, tobacco barns, stores, and various cemeteries (Global Security website, July 2005).

The initial land transferred to the government was acquired in 14 different transactions between April and October 1941 and totaled 173.8 square miles or 111,155 acres, of which there were 85,155 land acres and about 26,000 acres under water (Loftfield, 1981, Louis Berger Group, 2002).

Land planning for the Hadnot Point area began in late April 1941. The area was to contain the permanent administrative, housing, and subsistence buildings for the 1stMarDiv and was purchased under the name Area D (Louis Berger Group, 2002). W.P.T. Hill Field appears to have been originally located across approximately 10 tracts of various sizes (John Jordan, 2005). At the time of purchase in November 1941 and September 1942, the land tracts contained structures such as school, cabins, cribs, smokehouses, stables, and barns (Dept of the Navy, November 1941, September 1942). The facility at that time was known as Marine Barracks New River, N.C. and was changed to MCB Camp Lejeune in 1942 (Global Security website, July 19, 2005).

### 2.2.2 Operational History

Following the acquisition of the Parade Ground portions of Area D, the *New Pioneer* reported in March 1943 that new athletic fields were under construction on the land that now makes up the Parade Ground and surrounding field. The athletic fields would be on the east side of Holcomb Boulevard, opposite the Post Administration Building, and would encompass a parade ground, four baseball diamonds, and a football stadium with a quarter mile track around it. The construction would be completed within 30 days, or April 1943. The boundaries then were the same as they are now, with the area being bounded by Holcomb Boulevard on the west, Gum Street on the north, McHugh Boulevard on the south, and Louis Road on the east.

A 1943 map of the area shows the football field, baseball diamonds, and eight other buildings, including the base heating plant (see Attachment 2). To the north was the supply and industrial area, extending from Gum Street to Ash Street. Railroad tracks that brought coal to the heating plant ran through the length of the industrial area. On the western side of Holcomb Boulevard, from Molly Pitcher Drive to Main Service Road (now named McHugh Boulevard), was the Women's Reserve area, an administrative area that included the Post Headquarters. Regimental Areas 1-5 were located south of McHugh Boulevard. Historical photographs depict the area as it looked in 1944 and 1948 (see Photographs 1 and 2 in Attachment 2).

A 1954 map of historical features shows the area largely unchanged except for some additional buildings. The addition of the Field House, Building 751, added a major recreational resource to the base (also see Photograph 3 in Attachment 2).

Also noted on the map was the addition of the Base CS Chamber and NBC (Nuclear, Biological, and Chemical) Trail. The CS Chamber is located about 200 meters east of the Field House. The chamber was used to simulate chemical explosion situations. The Training Trail indicates the trail of decontamination procedures soldiers conducted before they could leave the facility. The Base CS Chamber and the NBC Trail were also documented in the Range Identification and Preliminary Assessment Report (USACE, 2001), which listed the

following agents, chemical agent simulants, and munitions as having reportedly been used at this location:

- CS (O-Chlorobenzylidenemalononitrile, a non-lethal riot control agent)
- Simulants Chemical Agent PEG 200 (polyethylene glycol)
- Training Set, Chemical Agent Identification, Simulants M72A1/A2
- Blister Agent Simulant, Molasses Residuum
- Training Ammunitions (i.e., tear gas grenades, etc.)
- Atomic Explosion Simulator DVC 39-1
- Atomic Simulator (fabricated locally IAW FM 30-101)
- Artillery Simulator, M110.

No information is available to provide an estimated quantity of usage. The facility is estimated to have been in use from 1985 to 1987 (US Army Corp of Engineers, 2001, Duane Richardson, 2005). The Base CS Chamber and the NBC Trail location are shown on Figure A-3.

The recreational areas remained along with the Parade Ground on the 1964 map of the Hadnot Point area. There are additional industrial buildings on the northern end of the field as well as around the Base CS Chamber.

The Range Identification and Preliminary Assessment Report (USACE, 2001) identified a second gas chamber in the site area, the D-7 Gas Chamber located at Building 756. The gas chamber is estimated to have been in use from 1953 to 1961 and is thought to have primarily used tear gas (USACE, 2001). The reported D-7 Gas Chamber location is also shown on Figure A-3.

The 2002 Range Inventory Report (URS Corp., 2002) indicated the presence of a suspected firing range, designated as the Lejeune Cantonment 2.36-in. Bazooka Range, on the main cantonment area along with the D-7 Gas Chamber. During a January 2006 interview between base personnel and Mr. Don Cifelli, a retired EOD technician, Mr. Cifelli reported that he first responded to an inert practice 2.36" Bazooka round at the Parade Grounds off of Holcomb Boulevard sometime between 1974-1976. He stated that he probably responded to the findings of bazooka rounds eight or nine times at various locations within the Parade Grounds in the 1970's and two or three times when he was reassigned to MCB, Camp Lejeune in the 1990's.

Mr. Cifelli stated that since he found so many of the same ordnance in the area, he assumed that the area used to be a bazooka range at some time in the past. Mr. Cifelli is unaware of the actual location or extent of the suspected range. However, the 2002 Range Inventory Report (URS Corp., 2002) described the location of the suspected historical range as centrally located on the MCB Camp Lejeune cantonment area, with the area designation based on EOD interviews.

Current base personnel has no knowledge of this area ever being a live fire range for bazookas or any other munitions due to its close proximity to the main administrative and industrial area of the base (Jordan, 2005, Richardson, 2005). The nearest historical range was located around Building 1502 and was an indoor firing range for small bore rifles (Richardson, 2005).

Mr. Kimball, consulting historian for the base, reports that he has not encountered any documentation that supports the area as an established range. Mr. Kimball stated that, while ordnance is likely to be found in any given area of the base, the likelihood of W.P.T. Field being used as a range is slim (Kimball, 2005).

There have been several previous investigations dating back to 1983 that have included the Parade Ground area. A significant study was the Remedial Investigation (RI) completed in 1994 at MCB Camp Lejeune Operable Unit (OU) No. 1, which is comprised of Sites 21, 24, and 78. Site 78, which houses the industrial area of the base, also includes the Parade Ground area. The site covers an area of approximately 590 acres and is comprised of maintenance shops, warehouses, painting shops, auto body shops, and other similar facilities. Due to the industrial nature of the site, many spills and leaks have occurred over the years that have impacted the soil and groundwater in the area. Most of these spills and leaks have consisted of petroleum-related products and solvents from underground storage tanks (USTs), drums, and uncontained waste storage areas (Baker, 1994).

Figure A-4 shows the area's proximity to the nearest storage tanks, hazardous material/waste storage areas, solid waste management units, and CERCLA sites. There are several CERCLA sites in the immediate vicinity of the Parade Ground area, primarily due to aboveground storage tanks associated with the industrial area.

SECTION 3

# Findings

## 3.1 Findings Related to MEC Activities

A review of available historical documents and interviews with current and former MCB Camp Lejeune personnel indicate the following potential areas of concern with regard to MEC-related activities in the Parade Ground area:

- Suspected Camp Lejeune Cantonment 2.36-in. Bazooka Range
- Base CS Chamber and NBC Trail
- D7 Gas Chamber

### 3.1.1 Suspected Lejeune Cantonment 2.36-in. Bazooka Range

The 2002 Range Inventory Report (URS Corp., 2002) indicated the presence of a suspected firing range, designated as the Lejeune Cantonment 2.36-in. Bazooka Range. Retired base EOD personnel have reported the findings of bazooka rounds on several occasions at various locations within the Parade Grounds during the 1970s and 1990s. The suspected range has not been indicated on any other historical base documents reviewed during this research effort.

### 3.1.2 Base CS Chamber and NBC Trail

Base maps and the Range Identification and Preliminary Assessment Report indicate the presence of the Base CS Chamber and NBC Trail in the Parade Ground area (see Figure A-3). The CS Chamber is located about 200 meters east of the Field House and was used to simulate chemical explosion situations and decontamination procedures using various chemical agent simulants. The amount of chemical simulants used during the facility's operation, 1985 to 1987, is unknown.

### 3.1.3 D-7 Gas Chamber

The Range Identification and Preliminary Assessment Report (USACE, 2001) identified the D-7 Gas Chamber as being located at Building 756. The gas chamber is estimated to have been in use from 1953 to 1961 and is thought to have primarily used tear gas (USACE, 2001). The reported D-7 Gas Chamber location is shown on Figure A-3, at the southern boundary of W.P.T. Hill field along McHugh Boulevard.

The 2002 Range Inventory Report (URS Corp., 2002) also reported the presence of the D-7 Gas Chamber on the main cantonment area along with the suspected bazooka range.

## 3.2 Findings Related to HTW Activities

Due to the close proximity of the Parade Ground area to the Industrial Area of the base, many spills and leaks have occurred over the years that have impacted the soil and groundwater in the area. There are several CERCLA sites in the immediate vicinity of the Parade Ground area, primarily due to aboveground storage tanks associated with the industrial area, as shown on Figure A-4. An RI was completed in 1994 at MCB Camp Lejeune Operable Unit (OU) No. 1, which includes the Parade Ground Area as part of Site 78.

**SECTION 4**

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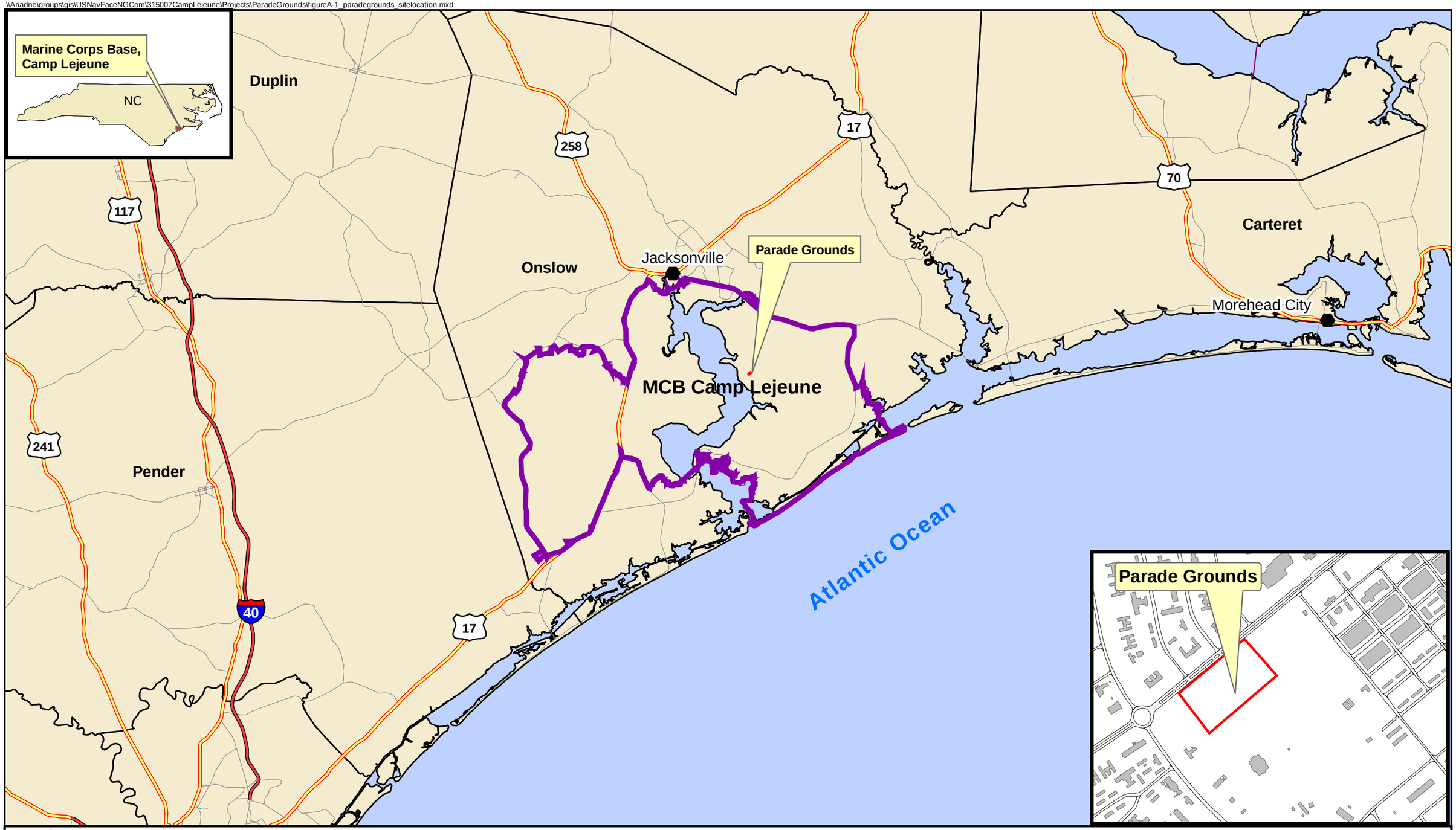


**Legend**

- Military Installation Area
- Parade Grounds
- Highway
- Limited Access Highway
- Local Roads
- Cities

N
W E
S

0 4,500 9,000 13,500 18,000
Meters

Figure A-1
Parade Grounds
Camp Lejeune Site Location Map
Camp Lejeune, North Carolina

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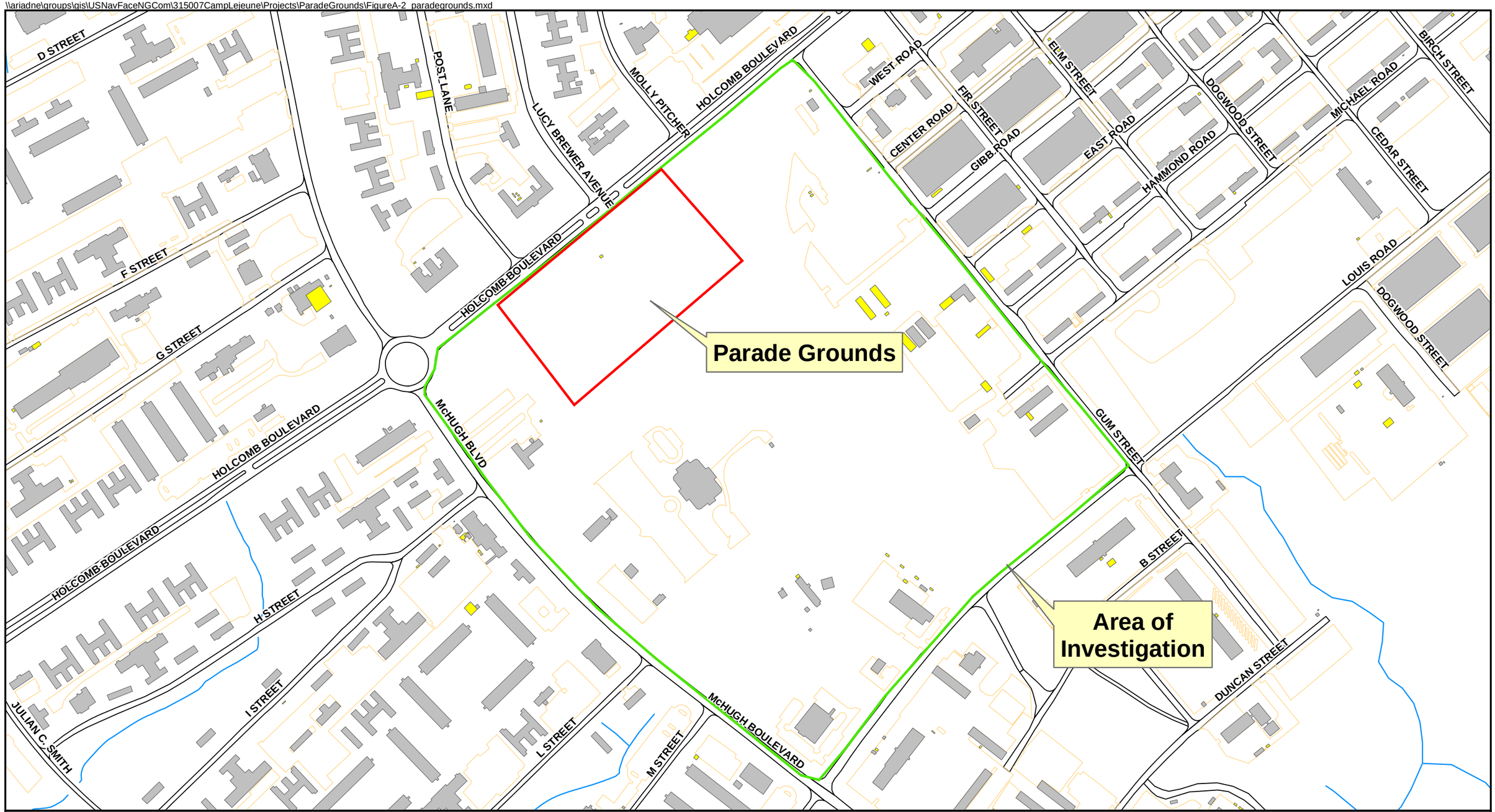


**Legend**

- Parade Grounds
- Area of Investigation
- Buildings
- Vehicle Parking Area
- Road Area

N
W E
S

100 0 100
Meters

Figure A-2
Parade Grounds
Camp Lejeune, North Carolina

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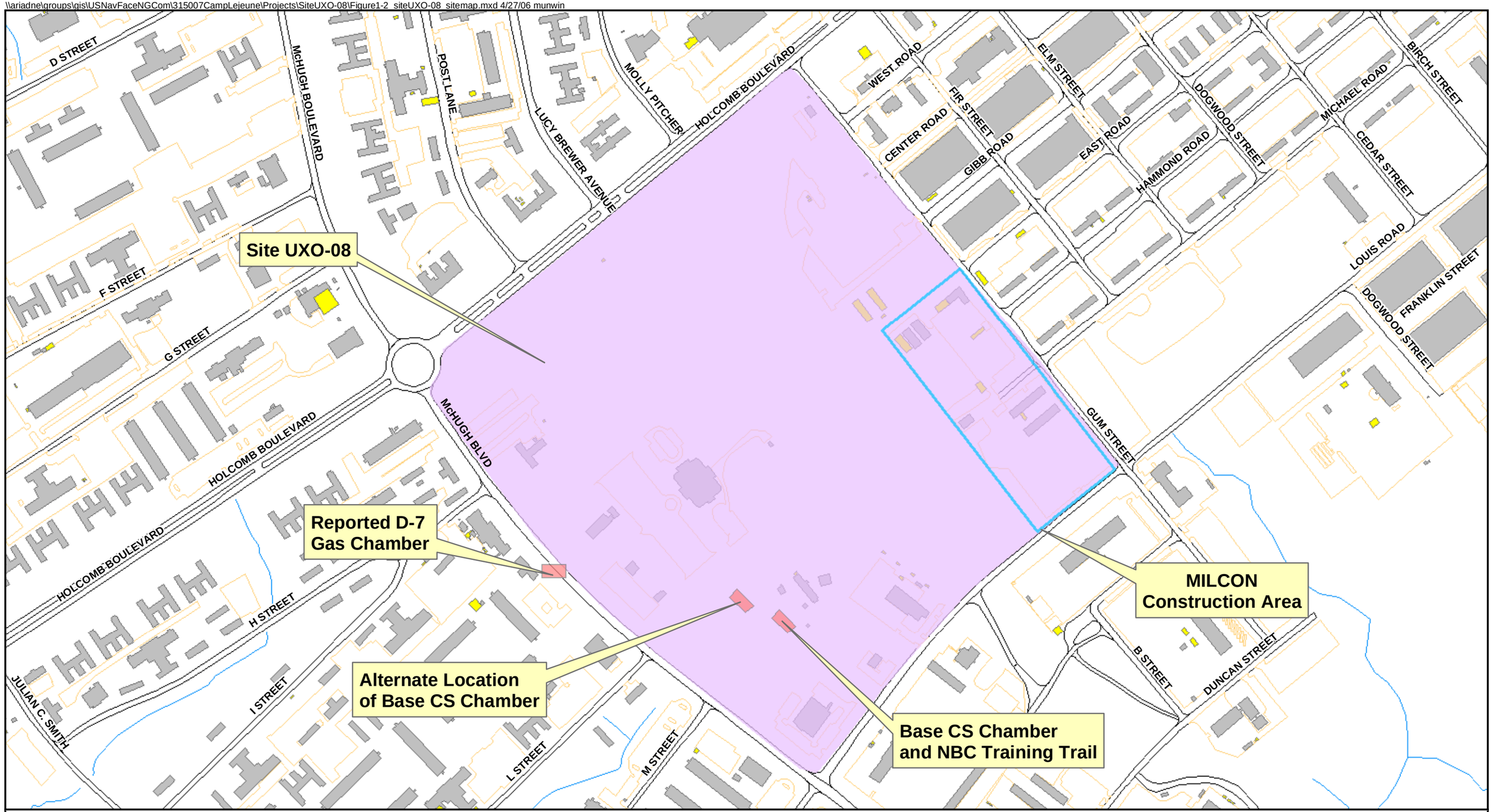


**Legend**

- PA/SI Work Area (Parade Ground Area)
- MILCON Construction Area
- Gas Chambers
- Buildings
- Vehicle Parking Area
- Road Area

N
W E
S

0 110 220
Meters

Figure A-3
Site UXO-08 Site Map
Camp Lejeune, North Carolina

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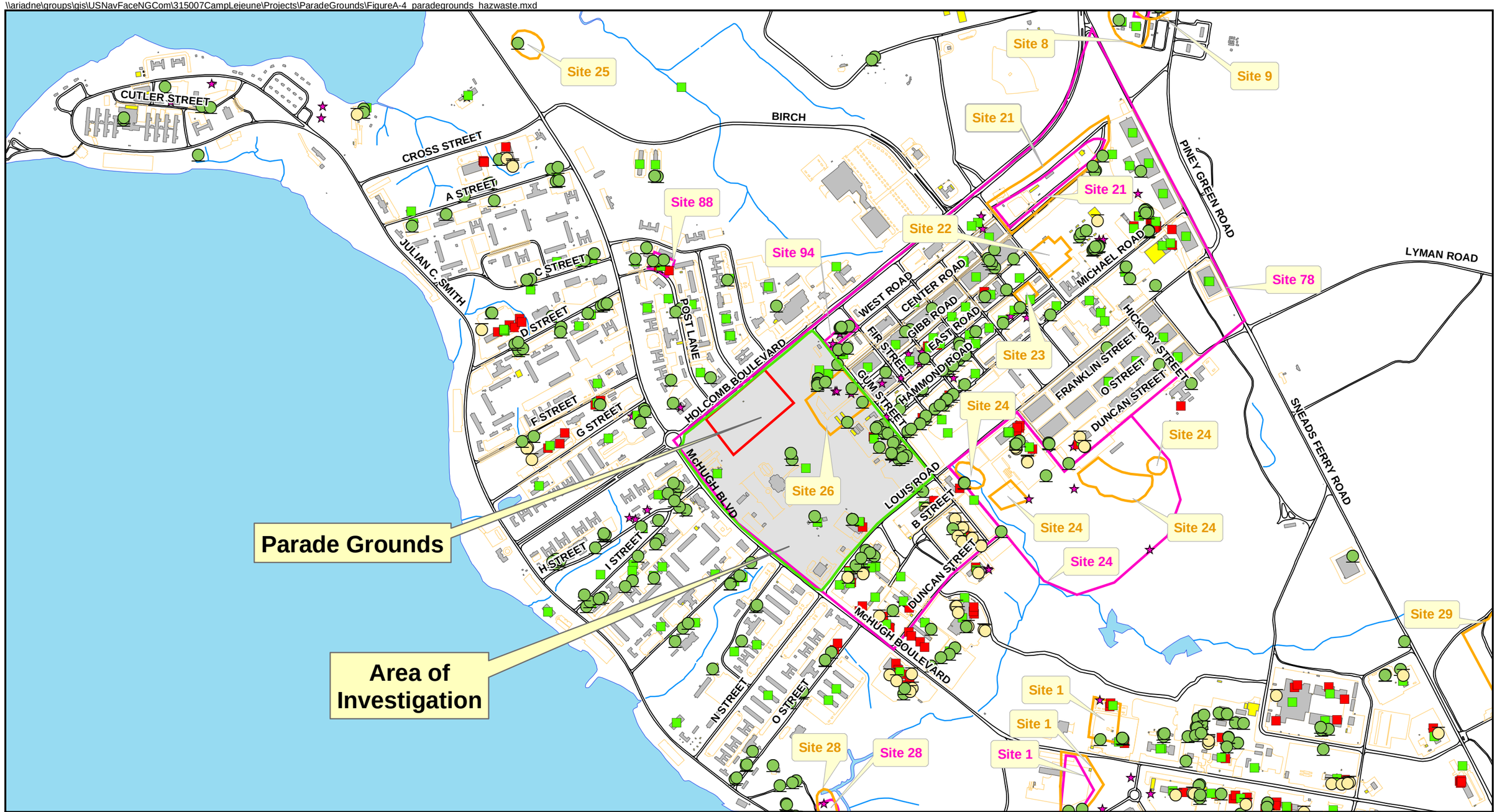


**Legend**

- Installation Area
- Structure Area
- Vehicle Parking Area
- Road Area
- Surface Water Course Centerline
- Surface Water Body Area
- Parade Grounds
- Area of Investigation
- Above Ground Storage Tank
- Underground Storage Tank
- CERCLA Pre-remediation Sites
- CERCLA Sites
- Initial Assessment Sites
- Hazardous Materials Storage
- Hazardous Waste Storage
- SWMUs

N W E S

400 0 400 Meters

Figure A-4
Proximity to Active Hazardous Wastes and Materials,
ASTs, USTs, LUSTs, SWMUs, CERCLA Sites, and IR Sites
Parade Grounds
Camp Lejeune, North Carolina

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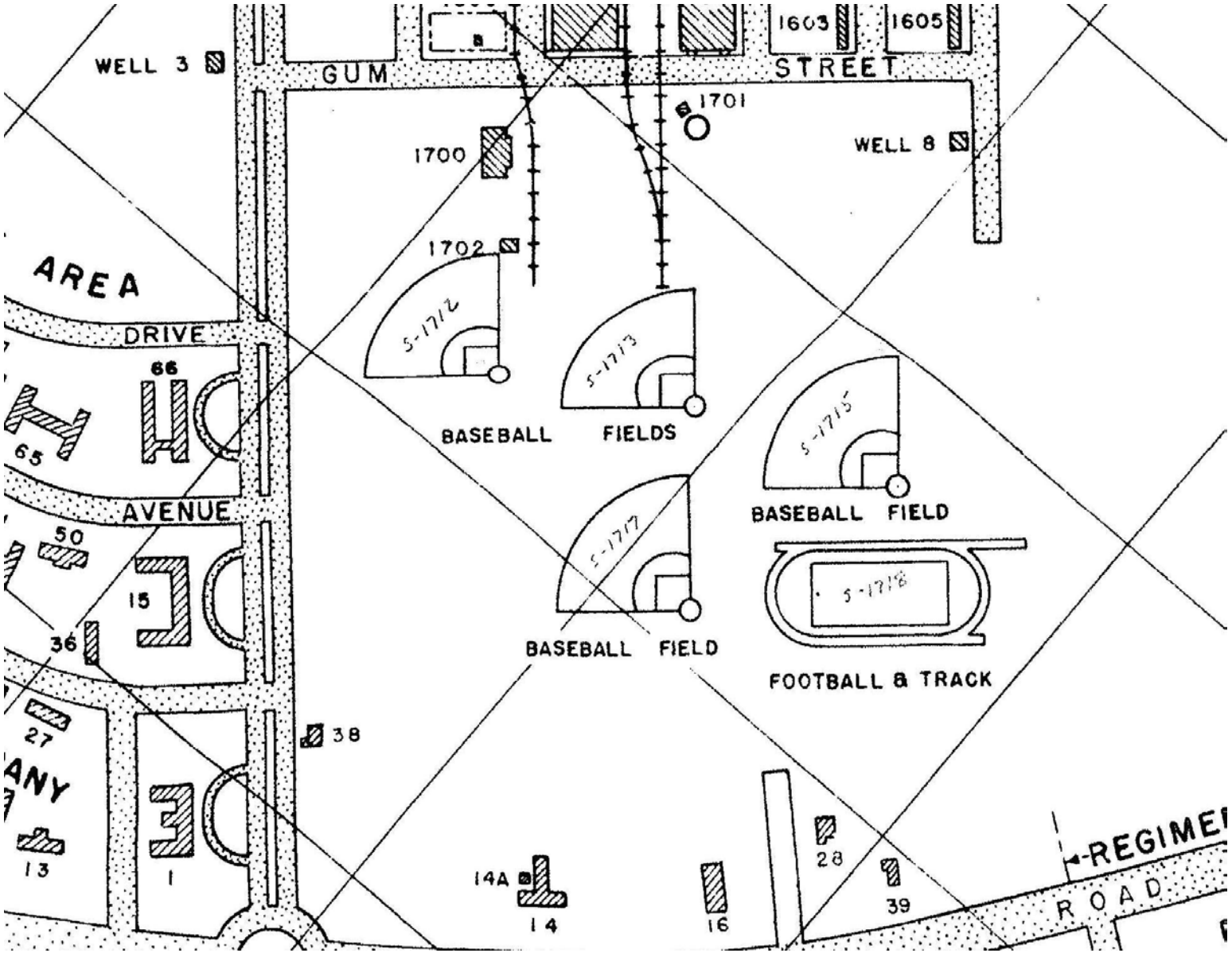
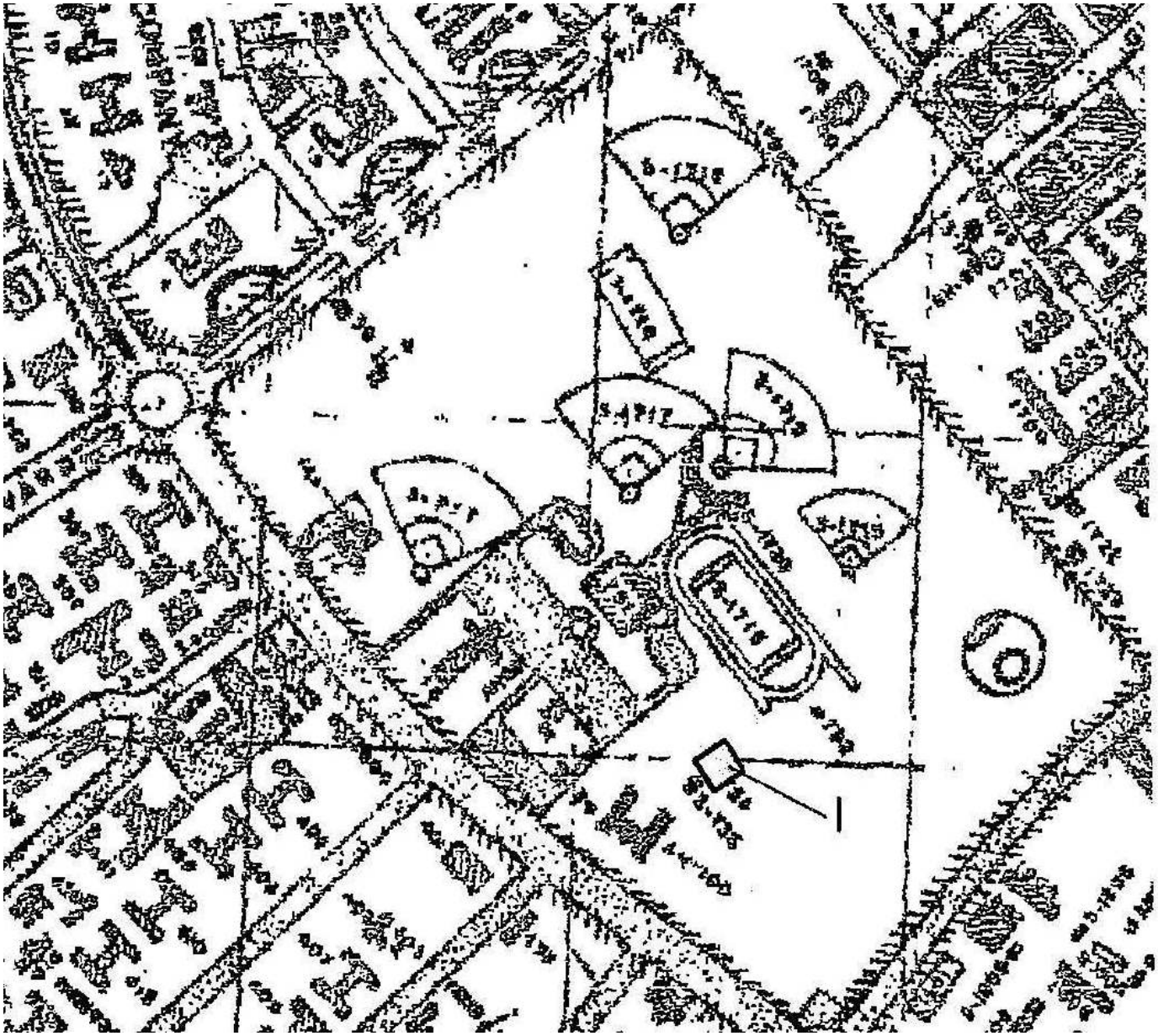



**MAP #1**
New River, N.C., Division Training Area, Camp Lejeune, New River, N.C., Showing Conditions on 30 June 1943.



KEY TO FEATURES:

| FEATURE NUMBER | FEATURE DESCRIPTION |
|---|---|
| 1 | BASE CS CHAMBER AND NBC TRAIL |
| 2 | RANGE D-6 - 50 FOOT SMALL BORE RANGE |

(Feature 2 is not shown on this Figure)

***NOTE: HISTORICAL MAP SHEET DATA USED IN THIS REPORT WAS RECTIFIED TO A CURRENT MAP PROVIDED BY MCB CAMP LEJEUNE USING INTERGRAPH CORPORATION SOFTWARE. THE ACCURACY OF FEATURES RECTIFIED FROM THE HISTORICAL MAP SHEET DATA TO THE CURRENT MCB CAMP LEJEUNE MAP MAY VARY.

0 300 600

APPROXIMATE SCALE IN METERS

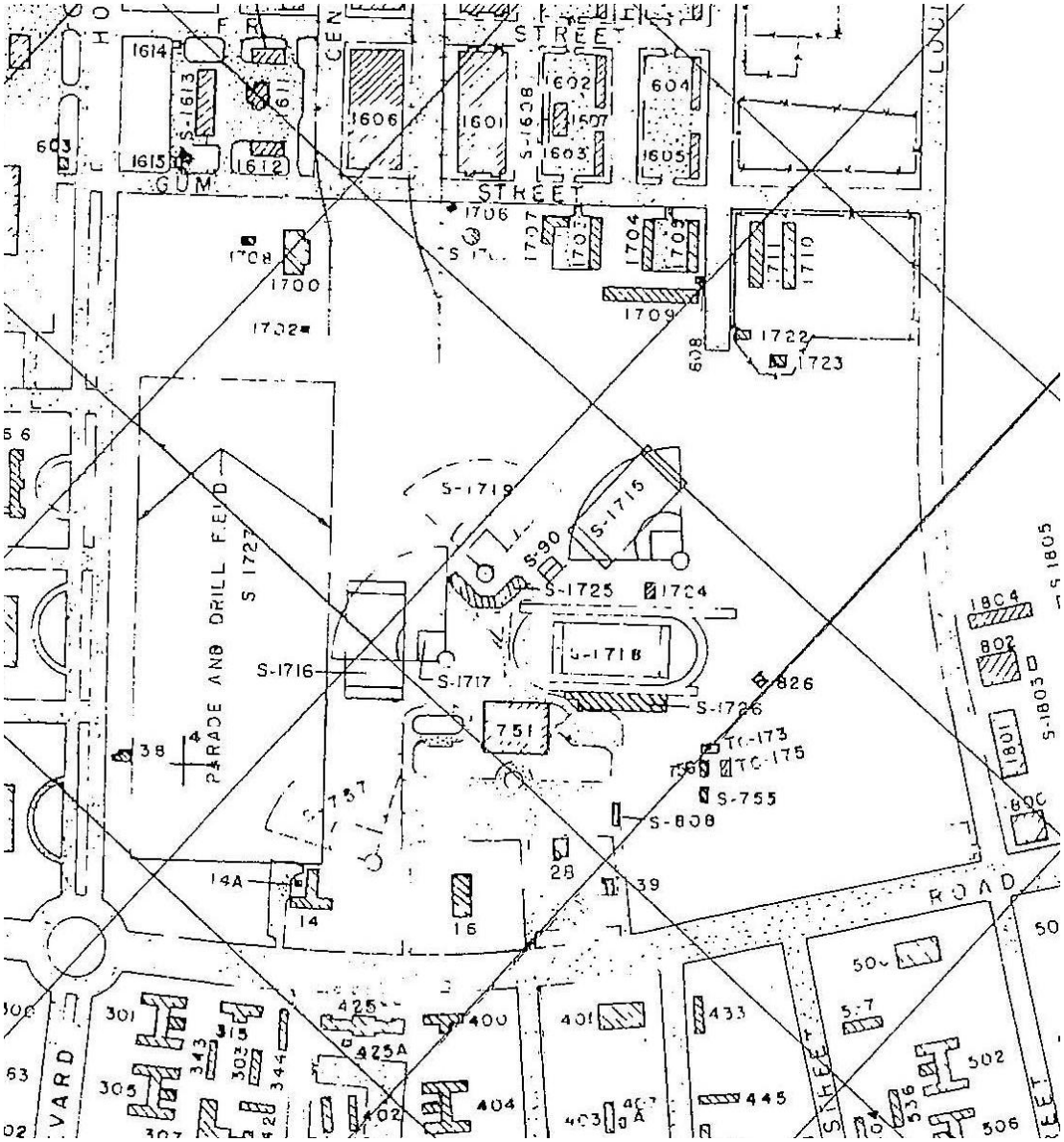
N

U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT

MARINE CORPS BASE
(MCB) CAMP LEJEUNE
JACKSONVILLE, NORTH CAROLINA
ONSLOW COUNTY
HISTORICAL FEATURES-JUNE 1954

PLATE NO. 22

**MAP #2**
Marine Corps Base Camp Lejeune
Jacksonville, North Carolina, Onslow County
Historical Features, June 1954.




**MAP #3**
MCB Camp Lejeune. Map of Hadnot Point Area and Vicinity, Camp Lejeune, North Carolina, Showing Conditions on June 30, 1964.

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# Attachment 1
# Resource Review Summary

**ATTACHMENT 1**

# A. Resource Review Summary

The following table provides a summary of the specific references identified for review, interview, or contact for the archival report.

| Resource | Actions Completed |
|---|---|
| Washington Navy Yard, Marine Corp Library<br>WNY Historical Center, Operational Archives Branch | Reviewed all available file folders related to Camp Lejeune. |
| MCB Quantico, Marine Corp Library, Great Research Center, History Division | Reviewed all available photograph folders related to Camp Lejeune and copied relevant aerial photographs. |
| Lena Kaljot/MCB Quantico | See *Marine Corp Library Review* |
| US National Archives (NARA II) Historical Files | Reviewed text and drawing files from Text Division and Cartographic Division. |
| Barry Zirby/National Archives Text File | See *US National Archives Files Review* |
| Camp Lejeune Library files | Reviewed and copied all relevant documents related to historical land use at the Parade Ground. |
| Camp Lejeune Real Estate files | Reviewed and copied all relevant documents related to historical land use and land acquisition at the Parade Ground. |
| Camp Lejeune Website | Reviewed and copied all relevant documents related to historical land use at the Parade Ground. |
| **Camp Lejeune Personnel** | |
| Bob Lowder/Environmental | Contacted and interviewed. |
| John Jordan/ Real Estate Exert | Contacted and interviewed. |
| Glenn Pappas/MCB Camp Lejeune Military Historian | Contacted and interviewed. |
| Duane Richardson/ Base Range Safety Officer | Contacted and interviewed. |
| **Other Contacts** | |
| Lt. Col. Lynn Kimball (U.S.M.C. Ret) /historical consultant | Contacted and interviewed. |

Note: Previous research efforts for Camp Lejeune have indicated no information is available at the following agencies: US National Archives (WDC); US National Archives, Philadelphia Region; US National Archives, Atlanta Region; and MCB Quantico, Marine Corp Library, Great Research Center, History Division, Text Department. As a result, these agencies were not contacted for research regarding the Parade Ground.

# A.1 MCB Quantico, Marine Corp Library, Great Research Center, History Department

## Photographic Division

Contact: Ms. Lena Kaljot, (703)/432-487
Site visit on December 30, 2005

Reviewed 10 file folders of photographs for Camp Lejuene:

1- Camp Lejuene, North Carolina Aerial Views, 1940-1960s

2- Camp Lejuene, North Carolina, Aerial Views Undated-photos primarily of the headquarters area

3- North Carolina General- photos primarily of the airstrip

4- Camp Lejuene, North Carolina 1948- primarily Pontoon Bridge Beach Area and main post buildings

5- Camp Lejuene, North Carolina Ice Cream Plant

6- Camp Lejuene, North Carolina Lumber

7- Camp Lejuene, North Carolina Midway Park, 1948

8- Camp Lejuene, North Carolina, Miscellaneous

9- Camp Lejuene, North Carolina, Training

10- Camp Lejuene, North Carolina, Storage

## List of Documents Obtained from MCB Quantico

Photo ID #1, folder 2, Undated and Unnamed Aerial Photo showing W.P.T. Field.

Photo ID #2, folder 1, *New River Ad Bldg. and Circle, 1 TMPS3-1033H, 8 ½", 8-22-44, 1345, 1000'.*

Photo ID #3, folder 1, *Division Training Area, Camp Lejuene, North Carolina, September 21, 1948, Ele. 4300, Looking West, Official Photograph, VMP354-458-9-48.*

Photo ID #4, folder 1, *Aerial View of Geottage Memorial Field House, Hadnot Point, , Camp Lejuene, North Carolina, August 15, 1957, 2102-1-8-57.*

# A.2 National Archives and Records Administration Review

## Text Division

Contact: Mr. Barry Zirby, 301-713-7250 x285
Site visit on November 10, 2005

Reviewed 18 boxes of files associated with the Marine Corps, 1939-1950

Record Group 127 (USMC), Office of the Commandant, General Correspondence, January 1939-June 1950, 1275/70-800 (10/45-1/47) to 1275/70-727 (1/44-12/47), Box 218.

Record Group 127 (USMC), Office of the Commandant, General Correspondence, January 1939-June 1950, 1275/70-800 (10/44-1/45) to 1275/70-800 (7/45-9/45), Box 219.

Record Group 127 (USMC), Office of the Commandant, General Correspondence, January 1939-June 1950, 2000-10 (1/48-12/48) to 2000-10 (5/24-12/36), Box 1201.

Record Group 127 (USMC), Office of the Commandant, General Correspondence, January 1939-June 1950, 2000-10 (6/45-4/46) to 2000-10 (5/44), Box 1202.

Record Group 127 (USMC), Office of the Commandant, General Correspondence, January 1939-June 1950, 2000-20 (1/49-10/49) to 2000-10 (1/45-6/45), Box 1203.

Record Group 127 (USMC), Office of the Commandant, General Correspondence, January 1939-June 1950, 2000-20 (1/44-6/47) to 2000-20 (5/48-12/48), Box 1204.

Record Group 127 (USMC), Office of the Commandant, General Correspondence, January 1939-June 1950, 2000-20-5 (6/46-12/47) to 2000-20 (6/43), Box 1205.

Record Group 127 (USMC), Office of the Commandant, General Correspondence, January 1939-June 1950, 2000-20-10 (7/48-10/47) to 2000-20-5 (4/45-6/46), Box 1206.

Record Group 127 (USMC), Office of the Commandant, General Correspondence, January 1939-June 1950, 2000-20-10 (7/41-11/42) to 2000-20-10 (1/45-6/45), Box 1207.

Record Group 127 (USMC), Office of the Commandant, General Correspondence, January 1939-June 1950, 2000-20-10 (7/39-2/40) to 2000-20-10 (2/40-6/41), Box 1208.

Record Group 127 (USMC), Office of the Commandant, General Correspondence, January 1939-June 1950, 2000-20-20 (1/48-12/48) to 2000-20-15 (1/49-6/50), Box 1209.

Record Group 127 (USMC), Office of the Commandant, General Correspondence, January 1939-June 1950, 2000-20-20 (1/44-11/46) to 2000-20-20 (11/46-12/47), Box 1210.

Record Group 127 (USMC), Office of the Commandant, General Correspondence, January 1939-June 1950, 2000-20-20 (2/33-8/36) to 2000-20-20 (6/42), Box 1211.

Record Group 127 (USMC), Office of the Commandant, General Correspondence, January 1939-June 1950, 2015 (3/43) to 2000-80 (1/44-12/47), Box 1241.

Record Group 127 (USMC), Office of the Commandant, General Correspondence, January 1939-June 1950, 2295-10 Brooklyn to 2285-10 Camp Lejuene, Box 1570.

Record Group 127 (USMC), Office of the Commandant, General Correspondence, January 1939-June 1950, 2295-10 Camp Lejuene to 2285-10 Camp Lejuene, Box 1571.

Record Group 127 (USMC), Office of the Commandant, General Correspondence, January 1939-June 1950, 2295-10 Camp Lejuene to 2285-10 Camp Lejuene, Box 1572.

Record Group 127 (USMC), Office of the Commandant, General Correspondence, January 1939-June 1950, 2295-10 Camp Lejuene to 2285-10 Camp Lejuene, Box 1573.

Record Group 127 (USMC), Office of the Commandant, General Correspondence, January 1939-June 1950, 2295-10 Camp Lejuene to 2285-10 Camp Lejuene, Box 1574.

The boxes contained information primarily related to weapons test results, weapons cost distribution, weapons training classes, weapon specifications, and cleaning and maintenance. The material was not specific to Camp Lejeune and included information for several MC bases.

### Cartographic Division

The cartographic division did not contain any relevant information pertaining to historical ordnance use in the Parade Ground area of Camp Lejuene. Information for Camp Lejuene is located under Record Group (RG) 71-Bureau of Yards and Docks. The index for locating cartographic materials is then grouped by subject codes. The only available drawing for Camp Lejuene was for Subject Area 19- Water Systems. Subject Areas 44 is Rifle ranges, machine gun ranges, sighting ranges, bombing targets; however, no materials were located under this Subject Area.

### List of Documents Obtained from National Archives

No documents were obtained from the National Archives.

## A.3 MCB Camp Lejeune Base Site Visit and Records Review

Base Contact: Mr. Bob Lowder, Environmental Management Division, 910-451-9607
Site visit December 7 and 8, 2005

File review of records in the base Real Estate office and base library were conducted during the site visit. Additionally, interviews were conducted with the Glenn Pappas/Military Historian, John Jordan/Real Estate expert, and Duane Richardson/EOD Base Range Safety Officer.

The file review focused on the Hadnot Point area of the base for the general period 1940-1960. A walkthrough of W.P.T. Field was conducted on December 7, 2005. No visual evidence of MEC or HTW contamination was observed.

Former base employee Lt. Col Lynn J. Kimball (USMC, Ret.) was contacted on November 21, 2005. Lt. Col. Kimball served as consulting historian on a book entitled *Semper Fidelis: A Brief History of Onslow County, North Carolina and MCB, Camp Lejuene*, which was also reviewed during the site visit.

## List of Documents Obtained from Camp Lejeune

### Base Real Estate Office

Department of the Navy, Appraisal Report, LA-Navy-Jacksonville, NC, Tract Nos. D-505, -526, -529, -530, -531, -536-538, -542, -545, November 1941 and September 1942.

New River, N.C., *Divison Training Area, Camp Lejeune, New River, N.C., Showing Conditions on 30 June 1943*.

### Base Library (Excerpts)

Louis Berger Group Inc. under USCOE, Wilmington district Contract DACWS4-99-C-0004, Semper Fidelis: A Brief History of Onslow County, North Carolina and MCB, Camp Lejuene, 2002, U.S.M.C., Lt. Col Lynn J. Kimball (USMC, Ret.), consulting historian.

Map of Hadnot Point Area and Vicinity, Camp Lejeune, North Carolina, Showing Conditions on June 30, 1964.

New River Pioneer (MBNR), "*Big Program of Athletics in Store Here, New Fields Under Construction*", Thursday, March 25, 1943, No. 28, Vol.1.

### EOD Office

Final Range Identification and Preliminary Range Assessment (ASR), Marine Corps Base Camp Lejeune, Onslow, North Carolina, December 2001, Prepared by US Army Corps of Engineers, St. Louis District.

### Environmental Office

Email documentation of phone call to Mr. Cifelli on 1-5-06 concerning 2.36" Bazooka Range (Lejeune Cantonment Range)

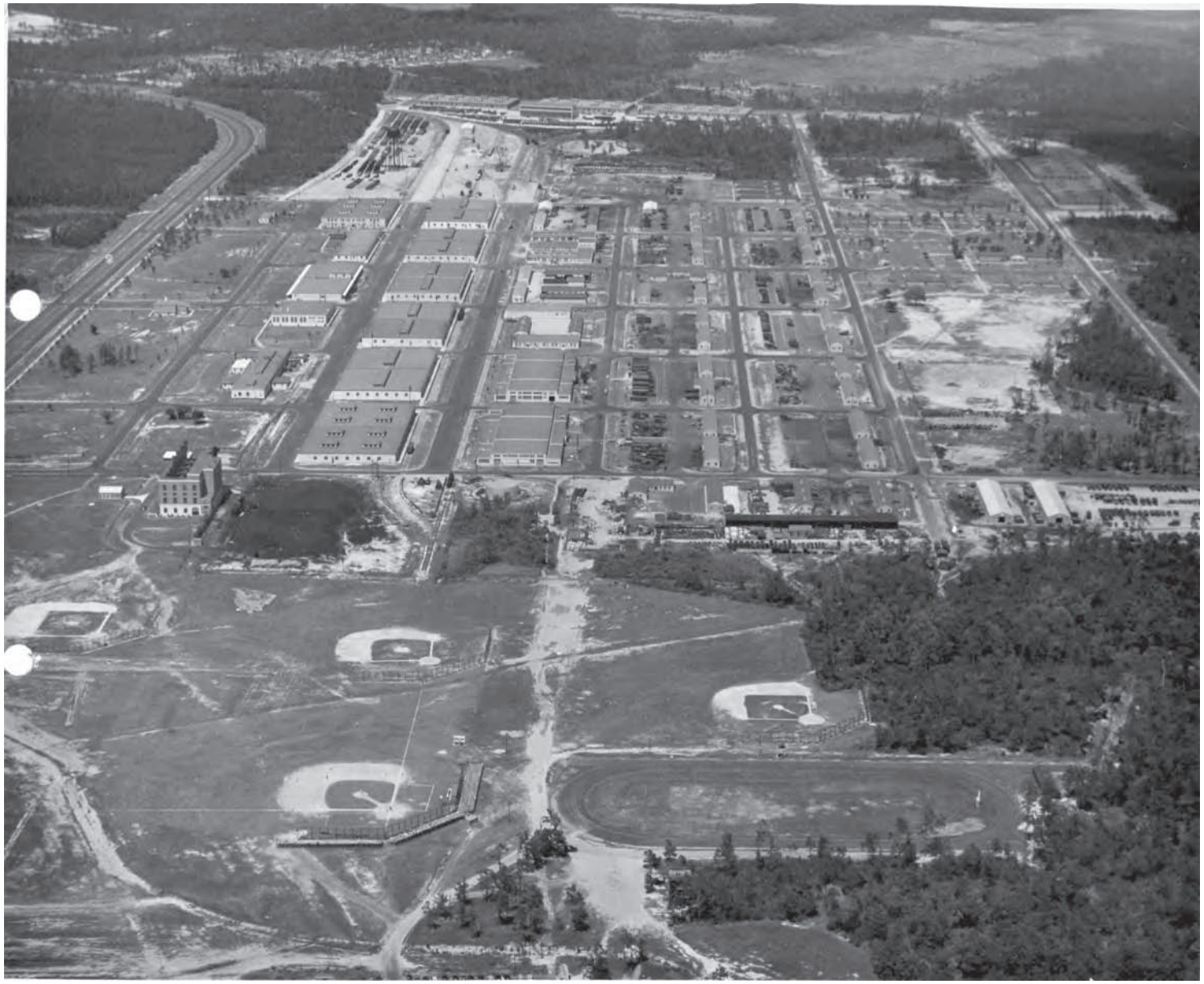

**PHOTO ID #1**
Updated and Unnamed Aerial Photo
showing W.P.T. Field
Camp Lejeune, North Carolina

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**PHOTO ID #2**
New River Ad Builing and Circle,
1 TMPS3-1033H, 8 ½", 8-22-44,
1345, 1000'
Camp Lejeune, North Carolina


**PHOTO ID #3**
New River Ad Builing and Circle,
1 TMPS3-1033H, 8 ½", 8-22-44,
1345, 1000'
Camp Lejeune, North Carolina

**PHOTO ID #4**
Aerial View of Geottage Memorial Field House, Hadnot Point, Camp Lejeune, North Carolina, August 15, 1957, 2102-1-8-57
Camp Lejeune, North Carolina

# Appendix B
# Health and Safety Plan

# CH2M HILL HEALTH AND SAFETY PLAN

This Health and Safety Plan (HSP) will be kept on the site during field activities and will be reviewed as necessary. The plan will be amended or revised as project activities or conditions change or when supplemental information becomes available. The plan adopts, by reference, the Standards of Practice (SOPs) in the CH2M HILL *Corporate Health and Safety Program, Program and Training Manual*, as appropriate. In addition, this plan adopts procedures in the project Work Plan. The Site Safety Coordinator (SSC) is to be familiar with these SOPs and the contents of this plan. CH2M HILL's personnel and subcontractors must sign Attachment 1.

# Project Information and Description

**PROJECT NO:** 330966

**CLIENT:** Navy

**PROJECT/SITE NAME:** CLEAN III CTO-109 / MCB Camp Lejeune, Site Inspection (SI), MRP Site UXO-08

**SITE ADDRESS:** Jacksonville, North Carolina

**CH2M HILL PROJECT MANAGER:** Tom Roth/ATL (CCI)

**CH2M HILL OFFICE:** Atlanta

**DATE HEALTH AND SAFETY PLAN PREPARED:** 1/24/2006

**DATE(S) OF SITE WORK:** August 2006 through December 2006

**SITE ACCESS:** Access to all sites is restricted. 'Main-Side" sites, including Site UXO-08 may be accessed through the Main Gate or the Piney Green Road Gate (contractors entrance) on the east side of the New River.

**SITE SIZE:** MCB, Camp Lejeune is approximately 236 square miles. Site UXO-08, subject of the SI, is approximately 166 acres.

**SITE TOPOGRAPHY**: The topography of MCB Camp Lejeune is relatively flat with ground surface elevations ranging from mean sea level (msl) to 72 feet above msl. Most of the MCB Camp Lejeune lies between 20 and 40 feet msl. Site UXO-08 is predominantly a flat area with surface elevation at 25 feet above msl. The 100-year flood plain elevation for this area of MCB Camp Lejeune is approximately 10 feet above msl.

**PREVAILING WEATHER**: The climate at MCB, Camp Lejeune is characterized by mild winters and hot humid summers. Winters are usually short and mild with occasional and short duration cold periods. Summers are long, hot and humid. Average annual net precipitation is approximately 50 inches. Ambient air temperatures generally range from 33 to 53 degrees Fahrenheit (°F) in the winter months, and 71°F to 88°F during the summer months. Winds are generally south-southwesterly in the summer, and north-northwesterly in the winter (Water and Air Research, 1983). The hurricane season in the immediate area surrounding Camp Lejeune begins on June 1 and continues through November 30. Storms of non-tropical origins such as frontal passages, local thunderstorms, and tornadoes are more frequent and can occur year-round.

**SITE DESCRIPTION AND HISTORY**: Construction of MCB, Camp Lejeune began in 1941 with the objective of developing the "World's Most Complete Amphibious Training Base". Construction of the Base started at Hadnot Point where the major functions of the Base are centered. During World War II, MCB, Camp Lejeune was used as a training area to prepare Marines for combat. MCB, Camp Lejeune was again used for training during the Korean and Vietnam conflicts, and the Gulf War. MCB, Camp Lejeune is host to five

Marine Corps commands and one Navy command. In addition, MCB Camp Lejeune provides support and training for the following tenet commands: Headquarters Nucleus; Second Marine Expeditionary Force; Second Marine Division; Second Marine Force Service Support Group; Second Marine Surveillance, Reconnaissance, and Intelligence Group; Sixth Marine Expeditionary Brigade; the Naval Hospital; and the Naval Dental Clinic. All of the real estate and infrastructure are owned, operated, and maintained by the host command. The mission of Camp Lejeune is to maintain combat ready units for expeditionary deployment.

MCB, Camp Lejeune is bisected by the New River, which flows in a southeasterly direction and forms a large estuary before entering the Atlantic Ocean. The Atlantic Ocean forms the southeastern boundary of the facility. The western and northwester boundaries are U.S. Route 17 and State Route 24, respectively. The City of Jacksonville, North Carolina is located immediately northwest of MCB, Camp Lejeune.

A majority of the land surrounding the facility is used for agriculture. Estuaries along the coast support commercial fishing and residential resort areas are located adjacent to MCB, Camp Lejeune along the Atlantic Ocean.

Site UXO-08 consists of approximately 166 acres located in the Hadnot Point area of the base. It is bounded by Holcomb Boulevard to the northwest, McHugh Boulevard to the southwest, and Louis Road to the southeast. To the northeast, the site is bounded by the portion of the suspected bazooka range firing fan that extends northeastward past Gum Street to a point near the intersection of East Road and Elm Street.

Site UXO-08 consists of the suspected former Lejeune Cantonment Bazooka Range, D-7 Gas Chamber, and Base CS Chamber and NBC (Nuclear, Biological, and Chemical) Trail (URS Corp., 2002). A 15-acre military construction (MILCON) project is planned within Site UXO-08. The MILCON construction footprint will be subjected to geophysical survey under a separate Construction Support Work Plan. The remaining 151 acres of Site UXO-08 will be overlain with a grid and up to 59 acres will be subjected to geophysical survey using towed-array (45 acres) and single-coil manually-towed (14 acres) methods.

The existing Parade Grounds, officially designated as W.P.T. Hill Field, are located within Site UXO-08 along the southeastern side of Holcomb Boulevard). The Parade Grounds are an expansive lawn used for ceremonies, receptions, parades, and other formal assemblies. It also hosts community gatherings, open-air concerts, including those by Camp Lejeune's 2d Marine Division Band, and athletic activities. W.P.T. Hill Field frequently serves as a helicopter landing zone for both administrative and tactical helicopter lifts (Camp Lejeune website, 2005). The Parade Grounds are surrounded on all four sides by industrial and administrative areas of the base. Refer to Figure 1-2.

The primary land use within Site UXO-08 consists of industrial and administrative areas. The eastern and northeastern portions of the site are primarily industrial and include the coal power plant and coal yard, while areas to the west and south-west are primarily administrative in nature.

**DESCRIPTION OF SPECIFIC TASKS TO BE PERFORMED**:

Due to historical activities within the project area (refer to Section 1.3), an SI is being conducted to accomplish the following objectives:

- Identify the presence and nature of any HTW contamination that may exist in the 15-acre MILCON area;
- Determine the presence or absence of munitions constituents (MC) in surface soil at Site UXO-08; and
- Evaluate the number and density of anomalies that could potentially represent subsurface MEC, while providing geophysical data for future MEC intrusive investigations or removal actions.

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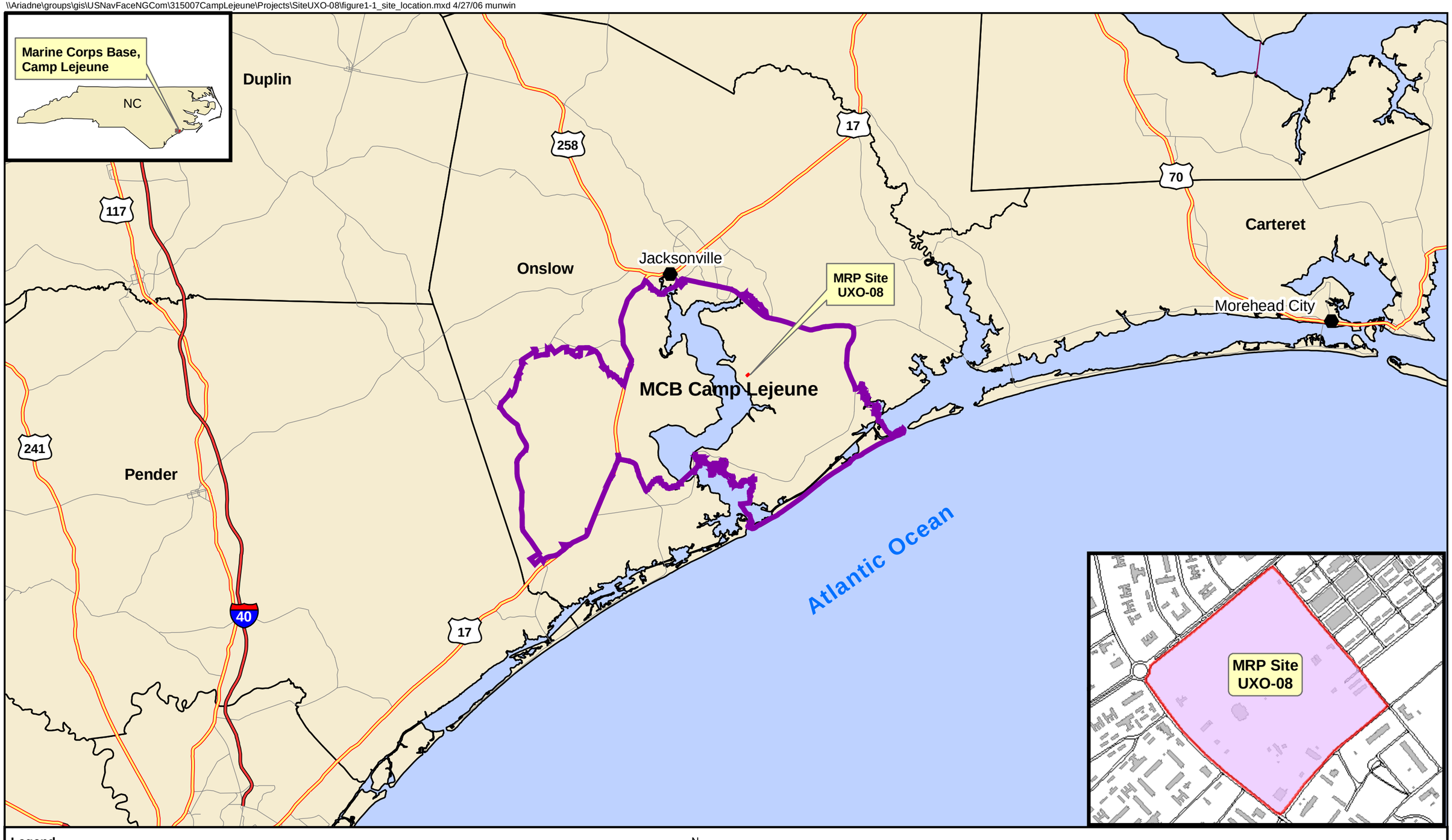


**Legend**
- Military Installation Area
- PA/SI Work Area (Parade Ground Area)
- Highway
- Limited Access Higwhay
- Local Roads
- Cities

N
W E
S

0 7 14
Kilometers

Figure 1-1
Site UXO-08 Location Map
Camp Lejeune, North Carolina

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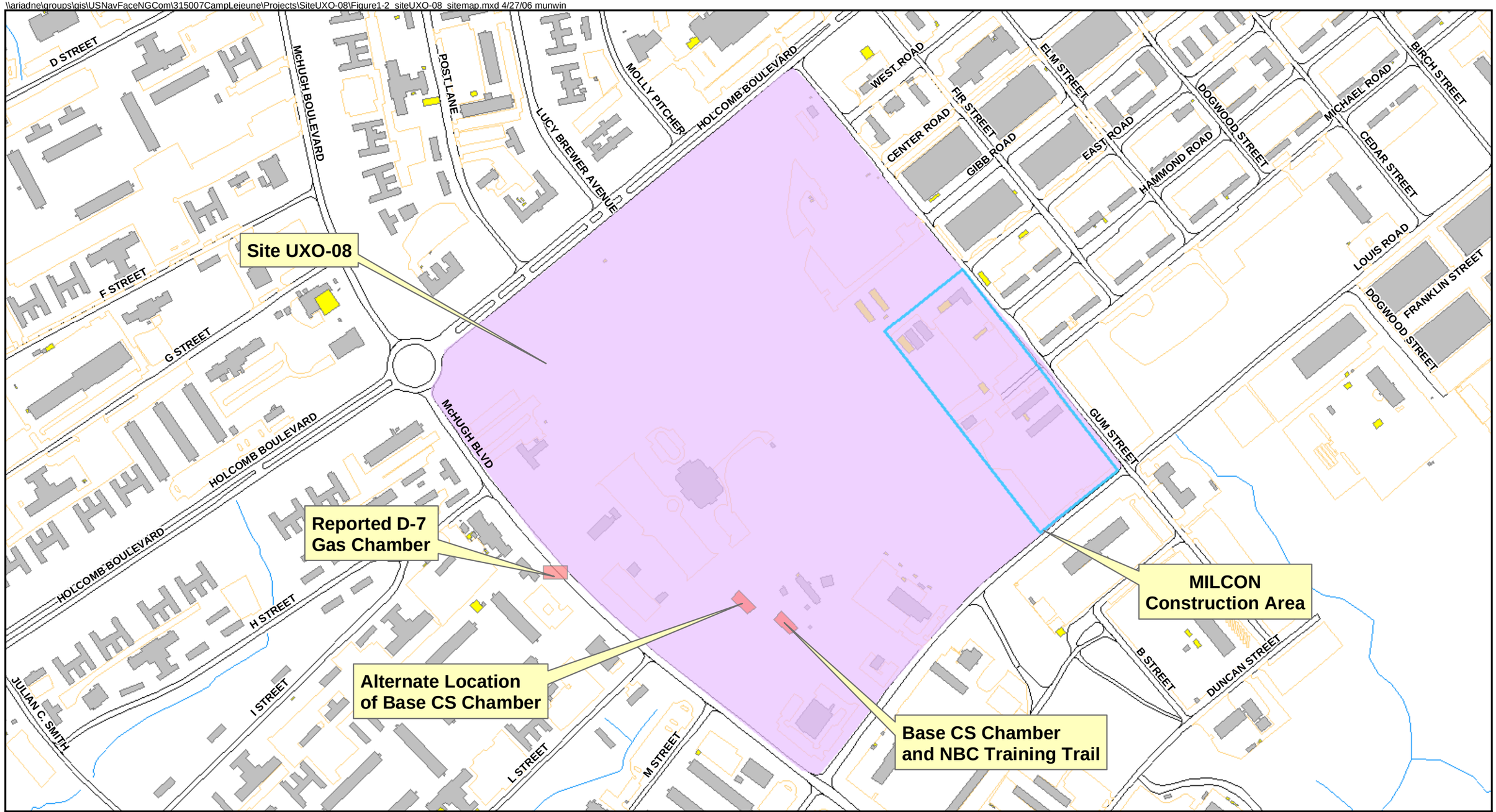
\\ariadne\groups\gis\USNavFaceNGCom\315007CampLejeune\Projects\SiteUXO-08\Figure1-2_siteUXO-08_sitemap.mxd 4/27/06 munwin




**Legend**

- PA/SI Work Area (Parade Ground Area)
- MILCON Construction Area
- Gas Chambers
- Buildings
- Vehicle Parking Area
- Road Area

N
W E
S

0 110 220
Meters

Figure 1-2
Site UXO-08 Site Map
Camp Lejeune, North Carolina

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# Table of Contents

# 1 Tasks to be performed under this Plan

## 1.1 Description of Tasks

(Reference Field Project Start-up Form)

Refer to project documents (i.e., Work Plan) for detailed task information. A health and safety risk analysis (Section 1.2) has been performed for each task and is incorporated in this plan through task-specific hazard controls and requirements for monitoring and protection. Tasks other than those listed below require an approved amendment or revision to this plan before tasks begin. Refer to Section 8.2 for procedures related to "clean" tasks that do not involve hazardous waste operations and emergency response (Hazwoper).

### 1.1.1 Hazwoper-Regulated Tasks

- Geoprobe boring
- Groundwater monitoring

### 1.1.2 Non-Hazwoper-Regulated Tasks

Under specific circumstances, the training and medical monitoring requirements of federal or state Hazwoper regulations are not applicable. It must be demonstrated that the tasks can be performed without the possibility of exposure in order to use non-Hazwoper-trained personnel. **Prior approval from the Health and Safety Manager (HSM) is required before these tasks are conducted on regulated hazardous waste sites.**

## 1.2 Task Hazard Analysis

(Refer to Section 2 for hazard controls)

| POTENTIAL HAZARDS | TASKS | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | **Groundwater monitoring** | **Direct Push and Geoprobe** | | | | |
| Flying debris/objects | | | | X | | | | |
| Noise > 85dBA | | | | X | | | | |
| Electrical | | | X | X | | | | |
| Suspended loads | | | | X | | | | |
| Buried utilities, drums, tanks | | | | X | | | | |
| Slip, trip, fall | | | X | X | | | | |
| Back injury | | | X | X | | | | |
| Confined space entry | | | | | | | | |
| Trenches / excavations | | | | | | | | |
| Visible lightning | | | X | X | | | | |
| Vehicle traffic | | | | X | | | | |
| Elevated work areas/falls | | | | X | | | | |
| Fires | | | | | | | | |
| Entanglement | | | | X | | | | |
| Drilling | | | | X | | | | |
| Heavy equipment | | | | X | | | | |
| Working near water | | | | | | | | |
| Working from boat | | | | | | | | |
| IDW Drum Sampling | | | | | | | | |

# 2 Hazard Controls

This section provides safe work practices and control measures used to reduce or eliminate potential hazards. These practices and controls are to be implemented by the party in control of either the site or the particular hazard. CH2M HILL employees and subcontractors must remain aware of the hazards affecting them regardless of who is responsible for controlling the hazards. CH2M HILL employees and subcontractors who do not understand any of these provisions should contact the SSC for clarification.

In addition to the controls specified in this section, Project-Activity Self-Assessment Checklists are contained in Attachment 6. These checklists are to be used to assess the adequacy of CH2M HILL and subcontractor site-specific safety requirements. The objective of the self-assessment process is to identify gaps in project safety performance, and prompt for corrective actions in addressing these gaps. Self-assessment checklists should be completed early in the project, when tasks or conditions change, or when otherwise specified by the HSM. The self-assessment checklists, including documented corrective actions, should be made part of the permanent project records, and be promptly submitted to the HSM.

**Project-specific frequency for completing self-assessments: Bi-weekly or at the beginning of each project phase.**

## 2.1 Project-Specific Hazards

### 2.1.2 Benzene

- Do not enter regulated work areas unless training, medical monitoring, and PPE requirements established by the competent person have been met.
- Do not eat, drink, smoke, chew tobacco or gum, or apply cosmetics in regulated areas.
- Skin absorption is a potential route of benzene exposure.
- Benzene is considered a “Confirmed Human Carcinogen.”
- A Short Term Exposure Limit (STEL: 15 minutes) exists for this material.
- Benzene has an aromatic odor.
- Respiratory protection and other exposure controls selection shall be based on the most recent exposure monitoring results obtained from the competent person.

## 2.2 General Hazards

### 2.2.1 General Practices and Housekeeping

(Reference CH2M HILL SOP HS-209, *General Practices*)

- Site work should be performed during daylight hours whenever possible. Work conducted during hours of darkness require enough illumination intensity to read a newspaper without difficulty.
- Good housekeeping must be maintained at all times in all project work areas.
- Common paths of travel should be established and kept free from the accumulation of materials.
- Keep access to aisles, exits, ladders, stairways, scaffolding, and emergency equipment free from obstructions.
- Provide slip-resistant surfaces, ropes, and/or other devices to be used.
- Specific areas should be designated for the proper storage of materials.
- Tools, equipment, materials, and supplies shall be stored in an orderly manner.
- As work progresses, scrap and unessential materials must be neatly stored or removed from the work area.
- Containers should be provided for collecting trash and other debris and shall be removed at regular intervals.
- All spills shall be quickly cleaned up. Oil and grease shall be cleaned from walking and working surfaces.

### 2.2.2 Hazard Communication

(Reference CH2M HILL SOP HS-05, *Hazard Communication)*

The SSC is to perform the following:

- Complete an inventory of chemicals brought on site by CH2M HILL using Attachment 2.
- Confirm that an inventory of chemicals brought on site by CH2M HILL subcontractors is available.
- Request or confirm locations of Material Safety Data Sheets (MSDSs) from the client, contractors, and subcontractors for chemicals to which CH2M HILL employees potentially are exposed.
- Before or as the chemicals arrive on site, obtain an MSDS for each hazardous chemical.
- Label chemical containers with the identity of the chemical and with hazard warnings, and store properly.
- Give employees required chemical-specific HAZCOM training using Attachment 3.
- Store all materials properly, giving consideration to compatibility, quantity limits, secondary containment, fire prevention, and environmental conditions.

### 2.2.3 Shipping and Transportation of Chemical Products

(Reference CH2M HILL's *Procedures for Shipping and Transporting Dangerous Goods)*

Chemicals brought to the site might be defined as hazardous materials by the U.S. Department of Transportation (DOT). All staff who ship the materials or transport them by road must receive CH2M HILL training in shipping dangerous goods. All hazardous materials that are shipped (e.g., via Federal Express) or are transported by road must be properly identified, labeled, packed, and documented by trained staff. Contact the HSM or the Equipment Coordinator for additional information.

### 2.2.4 Lifting

(Reference CH2M HILL SOP HS-112, *Lifting*)

- Proper lifting techniques must be used when lifting any object.
  - Plan storage and staging to minimize lifting or carrying distances.
  - Split heavy loads into smaller loads.
  - Use mechanical lifting aids whenever possible.
  - Have someone assist with the lift -- especially for heavy or awkward loads.
  - Make sure the path of travel is clear prior to the lift.

### 2.2.5 Fire Prevention

(Reference CH2M HILL SOP HS-22, *Fire Prevention*)

- Fire extinguishers shall be provided so that the travel distance from any work area to the nearest extinguisher is less than 100 feet. When 5 gallons or more of a flammable or combustible liquid is being used, an extinguisher must be within 50 feet. Extinguishers must:
  - be maintained in a fully charged and operable condition,
  - be visually inspected each month, and
  - undergo a maintenance check each year.
- The area in front of extinguishers must be kept clear.
- Post "Exit" signs over exiting doors, and post "Fire Extinguisher" signs over extinguisher locations.
- Combustible materials stored outside should be at least 10 feet from any building.
- Solvent waste and oily rags must be kept in a fire resistant, covered container until removed from the site.
- Flammable/combustible liquids must be kept in approved containers, and must be stored in an approved storage cabinet.

### 2.2.6 Electrical

(Reference CH2M HILL SOP HS-206 *Electrical*)

- Only qualified personnel are permitted to work on unprotected energized electrical systems.

- Only authorized personnel are permitted to enter high-voltage areas.
- Do not tamper with electrical wiring and equipment unless qualified to do so. All electrical wiring and equipment must be considered energized until lockout/tagout procedures are implemented.
- Inspect electrical equipment, power tools, and extension cords for damage prior to use. Do not use defective electrical equipment, remove from service.
- All temporary wiring, including extension cords and electrical power tools, must have ground fault circuit interrupters (GFCIs) installed.
- Extension cords must be:
  - equipped with third-wire grounding.
  - covered, elevated, or protected from damage when passing through work areas.
  - protected from pinching if routed through doorways.
  - not fastened with staples, hung from nails, or suspended with wire.
- Electrical power tools and equipment must be effectively grounded or double-insulated UL approved.
- Operate and maintain electric power tools and equipment according to manufacturers' instructions.
- Maintain safe clearance distances between overhead power lines and any electrical conducting material unless the power lines have been de-energized and grounded, or where insulating barriers have been installed to prevent physical contact. Maintain at least 10 feet from overhead power lines for voltages of 50 kV or less, and 10 feet plus ½ inch for every 1 kV over 50 kV.
- Temporary lights shall not be suspended by their electric cord unless designed for suspension. Lights shall be protected from accidental contact or breakage.
- Protect all electrical equipment, tools, switches, and outlets from environmental elements.

### 2.2.7 Heat Stress

(Reference CH2M HILL SOP HS-211, *Heat and Cold Stress*)

- Drink 16 ounces of water before beginning work. Disposable cups and water maintained at 50°F to 60°F should be available. Under severe conditions, drink 1 to 2 cups every 20 minutes, for a total of 1 to 2 gallons per day. Do not use alcohol in place of water or other nonalcoholic fluids. Decrease your intake of coffee and caffeinated soft drinks during working hours.
- Acclimate yourself by slowly increasing workloads (e.g., do not begin with extremely demanding activities).
- Use cooling devices, such as cooling vests, to aid natural body ventilation. These devices add weight, so their use should be balanced against efficiency.
- Use mobile showers or hose-down facilities to reduce body temperature and cool protective clothing.
- Conduct field activities in the early morning or evening and rotate shifts of workers, if possible.
- Avoid direct sun whenever possible, which can decrease physical efficiency and increase the probability of heat stress. Take regular breaks in a cool, shaded area. Use a wide-brim hat or an umbrella when working under direct sun for extended periods.
- Provide adequate shelter/shade to protect personnel against radiant heat (sun, flames, hot metal).
- Maintain good hygiene standards by frequently changing clothing and showering.
- Observe one another for signs of heat stress. Persons who experience signs of heat syncope, heat rash, or heat cramps should consult the SSC/DSC to avoid progression of heat-related illness.

| **SYMPTOMS AND TREATMENT OF HEAT STRESS** | | | | | |
|---|---|---|---|---|---|
| | Heat Syncope | Heat Rash | Heat Cramps | Heat Exhaustion | Heat Stroke |
| Signs and Symptoms | Sluggishness or fainting while standing erect or immobile in heat. | Profuse tiny raised red blister-like vesicles on affected areas, along with prickling sensations during heat exposure. | Painful spasms in muscles used during work (arms, legs, or abdomen); onset during or after work hours. | Fatigue, nausea, headache, giddiness; skin clammy and moist; complexion pale, muddy, or flushed; may faint on standing; rapid thready pulse and low blood pressure; oral temperature normal or | Red, hot, dry skin; dizziness; confusion; rapid breathing and pulse; high oral temperature. |

| SYMPTOMS AND TREATMENT OF HEAT STRESS | | | | | |
|---|---|---|---|---|---|
| | | | | low | |
| Treatment | Remove to cooler area. Rest lying down. Increase fluid intake. Recovery usually is prompt and complete. | Use mild drying lotions and powders, and keep skin clean for drying skin and preventing infection. | Remove to cooler area. Rest lying down. Increase fluid intake. | Remove to cooler area. Rest lying down, with head in low position. Administer fluids by mouth. Seek medical attention. | Cool rapidly by soaking in cool– but not cold–water. Call ambulance, and get medical attention immediately! |

**Monitoring Heat Stress**

These procedures should be considered when the ambient air temperature exceeds 70°F, the relative humidity is high (>50 percent), or when workers exhibit symptoms of heat stress.

The heart rate (HR) should be measured by the radial pulse for 30 seconds, as early as possible in the resting period. The HR at the beginning of the rest period should not exceed 100 beats/minute, or 20 beats/minute above resting pulse. If the HR is higher, the next work period should be shortened by 33 percent, while the length of the rest period stays the same. If the pulse rate still exceeds 100 beats/minute at the beginning of the next rest period, the work cycle should be further shortened by 33 percent. The procedure is continued until the rate is maintained below 100 beats/minute, or 20 beats/minute above resting pulse.

## 2.2.8 Cold Stress

(Reference CH2M HILL SOP HS-211, *Heat and Cold Stress*)

- Be aware of the symptoms of cold-related disorders, and wear proper, layered clothing for the anticipated fieldwork. Appropriate rain gear is a must in cool weather.
- Consider monitoring the work conditions and adjusting the work schedule using guidelines developed by the U.S. Army (wind-chill index) and the National Safety Council (NSC).
- Wind-Chill Index is used to estimate the combined effect of wind and low air temperatures on exposed skin. The wind-chill index does not take into account the body part that is exposed, the level of activity, or the amount or type of clothing worn. For those reasons, it should only be used as a guideline to warn workers when they are in a situation that can cause cold-related illnesses.
- NSC Guidelines for Work and Warm-Up Schedules can be used with the wind-chill index to estimate work and warm-up schedules for fieldwork. The guidelines are not absolute; workers should be monitored for symptoms of cold-related illnesses. If symptoms are not observed, the work duration can be increased.
- Persons who experience initial signs of immersion foot, frostbite, hypothermia should consult the SSC/DSC to avoid progression of cold-related illness.
- Observe one another for initial signs of cold-related disorders.
- Obtain and review weather forecast – be aware of predicted weather systems along with sudden drops in temperature, increase in winds, and precipitation.

| SYMPTOMS AND TREATMENT OF COLD STRESS | | | |
|---|---|---|---|
| | **Immersion (Trench) Foot** | **Frostbite** | **Hypothermia** |
| Signs and Symptoms | Feet discolored and painful; infection and swelling present. | Blanched, white, waxy skin, but tissue resilient; tissue cold and pale. | Shivering, apathy, sleepiness; rapid drop in body temperature; glassy stare; slow pulse; slow respiration. |
| Treatment | Seek medical treatment immediately. | Remove victim to a warm place. Re-warm area quickly in warm–but **not** hot–water. Have victim drink warm fluids, but **not** coffee or alcohol. Do | Remove victim to a warm place. Have victim drink warm fluids, but **not** coffee or alcohol. Get medical |

| | | | |
|---|---|---|---|
| | | not break blisters. Elevate the injured area, and get medical attention. | attention. |

### 2.2.11 Procedures for Locating Buried Utilities

**Local Utility Mark-Out Service**

Name: To be determined
Phone:

- Where available, obtain utility diagrams for the facility.
- Review locations of sanitary and storm sewers, electrical conduits, water supply lines, natural gas lines, and fuel tanks and lines.
- Review proposed locations of intrusive work with facility personnel knowledgeable of locations of utilities. Check locations against information from utility mark-out service.
- Where necessary (e.g., uncertainty about utility locations), excavation or drilling of the upper depth interval should be performed manually
- Monitor for signs of utilities during advancement of intrusive work (e.g., sudden change n advancement of auger or split spoon).
- When the client or other onsite party is responsible for determining the presence and locations of buried utilities, the SSC should confirm that arrangement.

## 2.3 Biological Hazards and Controls

### 2.3.1 Snakes

Snakes typically are found in underbrush and tall grassy areas. If you encounter a snake, stay calm and look around; there may be other snakes. Turn around and walk away on the same path you used to approach the area. If a person is bitten by a snake, wash and immobilize the injured area, keeping it lower than the heart if possible. Seek medical attention immediately. **DO NOT** apply ice, cut the wound, or apply a tourniquet. Try to identify the type of snake: note color, size, patterns, and markings.

### 2.3.2 Poison Ivy and Poison Sumac

Poison ivy, poison oak, and poison sumac typically are found in brush or wooded areas. They are more commonly found in moist areas or along the edges of wooded areas. Become familiar with the identity of these plants. Wear protective clothing that covers exposed skin and clothes. Avoid contact with plants and the outside of protective clothing. If skin contacts a plant, wash the area with soap and water immediately. If the reaction is severe or worsens, seek medical attention.

### 2.3.3 Ticks

Ticks typically are in wooded areas, bushes, tall grass, and brush. Ticks are black, black and red, or brown and can be up to one-quarter inch in size. Wear tightly woven light-colored clothing with long sleeves and pant legs tucked into boots; spray **only outside** of clothing with permethrin or permanone and spray skin with only DEET; and check yourself frequently for ticks.

If bitten by a tick, grasp it at the point of attachment and carefully remove it. After removing the tick, wash your hands and disinfect and press the bite areas. Save the removed tick. Report the bite to human resources. Look for symptoms of Lyme disease or Rocky Mountain spotted fever (RMSF). Lyme: a rash might appear that looks like a bullseye with a small welt in the center. RMSF: a rash of red spots under the skin 3 to 10 days after the tick bite. In both cases, chills, fever, headache, fatigue, stiff neck, and bone pain may develop. If symptoms appear, seek medical attention.

### 2.3.4 Bees and Other Stinging Insects

Bee and other stinging insects may be encountered almost anywhere and may present a serious hazard, particularly to people who are allergic. Watch for and avoid nests. Keep exposed skin to a minimum. Carry a kit if you have had allergic reactions in the past, and inform the SSC and/or buddy. If a stinger is present, remove it carefully with tweezers. Wash and disinfect the wound, cover it, and apply ice. Watch for allergic reaction; seek medical attention if a reaction develops.

### 2.3.5 Bloodborne Pathogens

(Reference CH2M HILL SOP HS-202, *Bloodborne Pathogens*)

Exposure to bloodborne pathogens may occur when rendering first aid or CPR, or when coming into contact with landfill waste or waste streams containing potentially infectious material. Exposure controls and personal protective equipment (PPE) are required as specified in CH2M HILL SOP HS-36, *Bloodborne Pathogens*. Hepatitis B vaccination must be offered before the person participates in a task where exposure is a possibility.

### 2.3.6 Mosquito Bites

Due to the recent detection of the West Nile Virus in the Southeastern United States it is recommended that **preventative measures** be taken to reduce the probability of being bitten by mosquitoes whenever possible. Mosquitoes are believed to be the primary source for exposure to the West Nile Virus as well as several other types of encephalitis . The following guidelines should be followed to reduce the risk of these concerns for working in areas where mosquitoes are prevalent.

- Stay indoors at dawn, dusk, and in the early evening.
- Wear long-sleeved shirts and long pants whenever you are outdoors.
- Spray clothing with repellents containing permethrin or DEET since mosquitoes may bite through thin clothing.
- Apply insect repellent sparingly to exposed skin. An effective repellent will contain 35% DEET (N,N-diethyl-meta-toluamide). DEET in high concentrations (greater than 35%) provides no additional protection.
- Repellents may irritate the eyes and mouth, so avoid applying repellent to the hands.
- Whenever you use an insecticide or insect repellent, be sure to read and follow the manufacturer's DIRECTIONS FOR USE, as printed on the product.

Note: Vitamin B and "ultrasonic" devices are NOT effective in preventing mosquito bites.

**Symptoms of Exposure to the West Nile Virus**

Most infections are mild, and symptoms include fever, headache, and body aches, occasionally with skin rash and swollen lymph glands. More severe infection may be marked by headache, high fever, neck stiffness, stupor, disorientation, coma, tremors, convulsions, muscle weakness, paralysis, and, rarely, death.

The West Nile Virus incubation period is from 3-15 days.

If you have any questions or to report any suspicious symptoms, contact the project Health and Safety Manager.

### 2.3.7 Fire Ant Bites

Fire ants are common in the southern U.S. These insects typically build mounds on the land surface that are usually easy to identify. Avoid disturbing these mounds. A bite from a fire ant can be painful but rarely is life threatening. However, it is possible that the bite could cause an allergic reaction. If bitten, check for symptoms of an allergic reaction such as weakness, nausea, vomiting, dizziness, or shortness of breath. If symptoms appear, seek medical attention

## 2.4 Radiological Hazards and Controls

Refer to CH2M HILL's *Corporate Health and Safety Program, Program and Training Manual,* and *Corporate Health and Safety Program, Radiation Protection Program Manual,* for standards of practice in contaminated areas.

| Hazards | Controls |
|---|---|
| None Known | None Required |

## 2.5 UXO/MEC

**MEC Avoidance Procedures.** MEC avoidance operations will be required during sampling operations. Avoidance operations will be conducted by one UXO Technician. The UXO Technician will not destroy any MEC encountered. All MEC contacts and suspected MEC anomalies will be reported to the site manager who will in turn notify in accordance with contractual requirements.

**Access routes to sampling locations.** Prior to sampling, the UXO Technicians will conduct a reconnaissance of the sampling area. The reconnaissance will include locating the designated sampling or drilling location(s) and insuring that they are free of anomalies. If anomalies are detected the point will be relocated as directed. Once the designed point has been cleared, an access route for the sampling crew's vehicles and equipment will be cleared. The access route, at a minimum will be twice the width of the widest vehicle and the boundaries will be clearly marked to prevent personnel from straying into non cleared areas. If surface MEC is encountered, the UXO Team will mark and report the item and divert the approach path around the MEC. A magnetometer will be used to ensure there are no subsurface MEC with the approach path. If a subsurface magnetic anomaly is encountered, it will be assumed to be a possible MEC and the path diverted to avoid it.

**Soil Sampling Sites.** The UXO Technicians will clear a work site for soil samples and clearly mark the boundaries. The area will be large enough to accommodate the direct push equipment and provide a work area for the crews. As a minimum, the cleared area will be a square, with a side dimension equal to twice the length of the largest vehicle or piece of equipment for use on site. If a pre-selected area indicates magnetic anomalies, a new sampling / drill site will be chosen.

**Borehole Sampling.** If surface samples are required they will be obtained prior to the start of boring. The borehole procedures will be completed using direct push technology (DPT) equipment. The UXO Technicians will check the borehole with a down hole magnetometer a minimum of every one foot, to the deepest sampling depth or a maximum of 2 feet to ensure that smaller items of MEC, undetectable from the surface will be detected. The anticipated depth of potential MEC items is anywhere from near-surface to < 1 ft, based on EM1110-1-4009 penetration calculations for M6A1 2.36" Rocket. Should any other MEC item other than the 2.36" rocket be identified on-site, work will stop and the depth of down hole will be reevaluated.

## 2.5 Contaminants of Concern

(Refer to Project Files for more detailed contaminant information)

| Contaminant | Location and Maximum[a] Concentration (ppm) | Exposure Limit[b] | IDLH[c] | Symptoms and Effects of Exposure | PIP[d] (eV) |
|---|---|---|---|---|---|
| Benzene | GW:<br>SB:<br>SS: | 1 ppm | 500<br>Ca | Eye, nose, skin, and respiratory irritation; headache; nausea; dermatitis; fatigue; giddiness; staggered gait; bone marrow depression | 9.24 |
| PNAs (Limits as Coal Tar Pitch) | GW:<br>SB:<br>SS: | 02 mg/$m^3$ | 80<br>Ca | Dermatitis and bronchitis | UK |
| 2,4,6-trinitrotoluene (TNT) and | GW:<br>SB:<br>SS: | 1.5 mg/$m^3$ | 500 mg/$m^3$ | Irritation skin, mucous membrane; liver damage, jaundice; cyanosis; sneezing; cough, sore throat; peripheral neuropathy, muscle pain; kidney damage; cataract; sensitization dermatitis; leukocytosis (increased blood leukocytes); anemia; cardiac irregularities | UK |
| 1,3-dinitrobenzene (DNB) | GW:<br>SB:<br>SS: | 1 mg/$m^3$ | 50 mg/$m^3$ | Anoxia, cyanosis; visual disturbance, central scotomas; bad taste, burning mouth, dry throat, thirst; yellowing hair, eyes, skin; anemia; liver damage | UK |

Footnotes:

[a] Specify sample-designation and media: SB (Soil Boring), A (Air), D (Drums), GW (Groundwater), L (Lagoon), TK (Tank), S (Surface Soil), SL (Sludge), SW (Surface Water).

[b] Appropriate value of PEL, REL, or TLV listed.

[c] IDLH = immediately dangerous to life and health (units are the same as specified "Exposure Limit" units for that contaminant); NL = No limit found in reference materials; CA = Potential occupational carcinogen.

[d] PIP = photoionization potential; NA = Not applicable; UK = Unknown.

## 2.6 Potential Routes of Exposure

| | | |
|---|---|---|
| **Dermal:** Contact with contaminated media. This route of exposure is minimized through proper use of PPE, as specified in Section 4. | **Inhalation:** Vapors and contaminated particulates. This route of exposure is minimized through proper respiratory protection and monitoring, as specified in Sections 4 and 5, respectively. | **Other:** Inadvertent ingestion of contaminated media. This route should not present a concern if good hygiene practices are followed (e.g., wash hands and face before drinking or smoking). |

# 3 Project Organization and Personnel

## 3.1 CH2M HILL Employee Medical Surveillance and Training

(Reference CH2M HILL SOPs HS-113, *Medical Surveillance,* and HS-02, *Health and Safety Training)*

The employees listed below are enrolled in the CH2M HILL Comprehensive Health and Safety Program and meet state and federal hazardous waste operations requirements for 40-hour initial training, 3-day on-the-job experience, and 8-hour annual refresher training. Employees designated "SSC" have completed a 12-hour site safety coordinator course, and have documented requisite field experience. An SSC with a level designation (D, C, B) equal to or greater than the level of protection being used must be present during all tasks performed in exclusion or decontamination zones. Employees designated "FA-CPR" are currently certified by the American Red Cross, or equivalent, in first aid and CPR. At least one FA-CPR designated employee must be present during all tasks performed in exclusion or decontamination zones. The employees listed below are currently active in a medical surveillance program that meets state and federal regulatory requirements for hazardous waste operations. Certain tasks (e.g., confined-space entry) and contaminants (e.g., lead) may require additional training and medical monitoring.

Pregnant employees are to be informed of and are to follow the procedures in CH2M HILL's SOP HS-04, *Reproduction Protection*, including obtaining a physician's statement of the employee's ability to perform hazardous activities before being assigned fieldwork.

| Employee Name | Office | Responsibility | SSC/FA-CPR |
|---|---|---|---|
| Dan Tomczak | ***RDU*** | ***Field Team Leader*** | SC-HW, FA-CPR<br>Level ___ SSC; FA-CPR |
| | | | |
| | | | |
| | | | |
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| | | | |
| | | | |

## 3.2 Field Team Chain of Command and Communication Procedures

### 3.2.1 Client

Client Contact
Daniel Hood, PE
NAVFAC Atlantic
Code: OPCEV
6506 Hampton Blvd
Norfolk, Virginia 23508-1278
757-322-4630
757-322-4805 fax
daniel.r.hood@navy.mil

Base Contact
Robert Lowder
Camp Lejeune - EMD
Building 12
Marine Corps Base
Camp Lejeune, NC 28542-0004
(910) 451-9607
(910) 451-5997
robert.a.lowder@usmc.mil

### 3.2.2 CH2M HILL

Project Manager: Tom Roth
Health and Safety Manager: Michael Goldman/ATL for General and Dan Young./NVR for MEC
Field Team Leader: Dan Tomczak/RDU
Site Safety Coordinator: Dan Tomczak/RDU
UXO Site Safety and Health Officer: TBD

The SSC is responsible for contacting the Field Team Leader and Project Manager. In general, the Project Manager will contact the client. The Health and Safety Manager should be contacted as appropriate.

**UXO TECHNICIAN II**

The UXO Technician II for this project will report directly to the Project Manager on issues pertaining to the operations at the Site UXO-08 project site. The UXO Technician II will have the following safety and health related responsibilities:

- Reports directly to the CH2M HILL Project Manager;
- Managing the funding, manpower and equipment necessary to safely conduct site operations;
- Reviewing and becoming familiar with the site Work Plan (WP) and SSHP;
- Provide copies of the WP and SSHP to site and subcontract personnel;
- Review the scope of work (SOW) and ensure that the required safety and health elements are addressed in the SSHP and/or WP;
- Coordinating the assignment of personnel and ensuring that the personnel and equipment provided meet the requirements of the WP and SSHP;
- Ensuring implementation of project quality, safety and health procedures;
- Early detection and identification of potential problem areas, including safety & health matters, and instituting corrective measures;
- Directly interfacing with the Project manager and advising him of safety and health matters related to conduct of the site operations.
- Acts as the On-Scene-Incident-Commander (OSIC) in the event of an MEC emergency, notifying and coordinating with off site emergency and medical response agencies.

**UXO SITE SAFETY AND HEALTH OFFICER**

The UXO Site Safety Officer (UXOSO) for this project reports directly to the Project Manager and oversees all UXO safety and heath aspects for this site. For this project the UXO Technician II will assume the duties of the UXOSO. He/she will coordinate all daily activities with the Project Manager. The UXOSO will have the following responsibilities;

- Has STOP WORK authority for UXO safety and heath reasons;
- Implement and enforce the SSHP, and report safety violations to the Project Manager and other appropriate personnel;
- Establishing work zones and controlling access to these zones;
- Conduct daily UXO Safety Briefings;
- Implement and document the Site Specific Hazard Information Training Program;
- Consulting with the SUXOS as necessary;
- Assisting in the continued development of this Avoidance Plan, and the SSHP and other safety and health procedures, as applicable;
- Investigate and report accidents/incidents and ‘near misses;”
- Conduct visitor orientation;
- Enforce the “buddy” system;
- Restrict site personnel from site activities if they exhibit systems of alcohol or drug use or illness, and continually monitor site personnel for signs of environmental exposure or physical stress;
- Maintain the site safety and monitoring logs;

- Maintains an alternate line of communication with the Project Manager.

**UXO TECHNICIANS**

All UXO Technicians are required to comply with the provisions of this Avoidance Plan, the SSHP, the WP and all applicable Federal, State and local regulations. They will report to the UXO Technician II.

### 3.2.3 CH2M HILL Subcontractors

(Reference CH2M HILL SOP HS-215, *Subcontractor, Contractor, and Owner*)

**Subcontractor: To be determined**
Subcontractor Contact Name:
Telephone:

The subcontractors listed above are covered by this HSP and must be provided a copy of this plan. However, this plan does not address hazards associated with the tasks and equipment that the subcontractor has expertise in (e.g., drilling, excavation work, electrical). Subcontractors are responsible for the health and safety procedures specific to their work, and are required to submit these procedures to CH2M HILL for review before the start of field work. Subcontractors must comply with the established health and safety plan(s). The CH2M HILL SSC should verify that subcontractor employee training, medical clearance, and fit test records are current and must monitor and enforce compliance with the established plan(s). CH2M HILL's oversight does not relieve subcontractors of their responsibility for effective implementation and compliance with the established plan(s).

CH2M HILL should continuously endeavor to observe subcontractors' safety performance. This endeavor should be reasonable, and include observing for hazards or unsafe practices that are both readily observable and occur in common work areas. CH2M HILL is not responsible for exhaustive observation for hazards and unsafe practices. In addition to this level of observation, the SSC is responsible for confirming CH2M HILL subcontractor performance against both the subcontractor's safety plan and applicable self-assessment checklists. Self-assessment checklists contained in Attachment 6 are to be used by the SSC to review subcontractor performance.

Health and safety related communications with CH2M HILL subcontractors should be conducted as follows:

- Brief subcontractors on the provisions of this plan, and require them to sign the Employee Signoff Form included in Attachment 1.
- Request subcontractor(s) to brief the project team on the hazards and precautions related to their work.
- When apparent non-compliance/unsafe conditions or practices are observed, notify the subcontractor safety representative and require corrective action – the subcontractor is responsible for determining and implementing necessary controls and corrective actions.
- When repeat non-compliance/unsafe conditions are observed, notify the subcontractor safety representative and stop affected work until adequate corrective measures are implemented.
- When an apparent imminent danger exists, immediately remove all affected CH2M HILL employees and subcontractors, notify subcontractor safety representative, and stop affected work until adequate corrective measures are implemented. Notify the Project Manager and HSM as appropriate.
- Document all oral health and safety related communications in project field logbook, daily reports, or other records.

### 3.2.4 Contractors

(Reference CH2M HILL SOP HS-215, *Subcontractor, Contractor, and Owner*)

**Contractor: To be determined**
Contractor Contact Name:
Telephone:

This plan does not cover contractors that are contracted directly to the client or the owner. CH2M HILL is not responsible for the health and safety or means and methods of the contractor's work, and we must never assume such responsibility through our actions (e.g., advising on H&S issues). In addition to this plan, CH2M HILL staff should review contractor safety plans so that we remain aware of appropriate precautions that apply to us. Except in unusual situations when conducted by the HSM, CH2M HILL must never comment on or approve contractor safety procedures. Self-assessment checklists contained in Attachment 6 are to be used by the SSC to review the contractor's performance ONLY as it pertains to evaluating our exposure and safety.

Health and safety related communications with contractors should be conducted as follows:

- Request the contractor to brief CH2M HILL employees and subcontractors on the precautions related to the contractor's work.
- When an apparent contractor non-compliance/unsafe condition or practice poses a risk to CH2M HILL employees or subcontractors:
  - Notify the contractor safety representative
  - Request that the contractor determine and implement corrective actions
  - If needed, stop affected CH2M HILL work until contractor corrects the condition or practice. Notify the client, Project Manager, and HSM as appropriate.
- If apparent contractor non-compliance/unsafe conditions or practices are observed, inform the contractor safety representative. Our obligation is limited strictly to informing the contractor of our observation – the contractor is solely responsible for determining and implementing necessary controls and corrective actions.
- If an apparent imminent danger is observed, immediately warn the contractor employee(s) in danger and notify the contractor safety representative. Our obligation is limited strictly to immediately warning the affected individual(s) and informing the contractor of our observation – the contractor is solely responsible for determining and implementing necessary controls and corrective actions.
- Document all oral health and safety related communications in project field logbook, daily reports, or other records.

# 4 Personal Protective Equipment (PPE)

(Reference CH2M HILL SOP HS-117, *Personal Protective Equipment*, HS-121, *Respiratory Protection*)

## PPE Specifications [a]

| Task | Level | Body | Head | Respirator [b] |
|---|---|---|---|---|
| General site entry<br>Surveying<br>Geophysical Surveying | D | Work clothes; steel-toe, leather work boots; work glove. | Hardhat [c]<br>Safety glasses<br>Ear protection [d] | None required |
| Geoprobe boring | Modified D | Work clothes or cotton coveralls<br>**Boots:** Steel-toe, chemical-resistant boots OR steel-toe, leather work boots with outer rubber boot covers<br>**Gloves:** Inner surgical-style nitrile & outer chemical-resistant nitrile gloves. | Hardhat [c]<br>Safety glasses<br>Ear protection [d] | None required |
| Groundwater sampling<br>Soil boring<br>Investigation-derived waste (drum) sampling and disposal | Modified D | **Coveralls:** Uncoated Tyvek®<br>**Boots:** Steel-toe, chemical-resistant boots OR steel-toe, leather work boots with outer rubber boot covers<br>**Gloves:** Inner surgical-style nitrile & outer chemical-resistant nitrile gloves. | Hardhat [c]<br>Splash shield [c]<br>Safety glasses<br>Ear protection [d] | None required. |

## Reasons for Upgrading or Downgrading Level of Protection

| Upgrade[f] | Downgrade |
|---|---|
| • Request from individual performing tasks.<br>• Change in work tasks that will increase contact or potential contact with hazardous materials.<br>• Occurrence or likely occurrence of gas or vapor emission.<br>• Known or suspected presence of dermal hazards.<br>• Instrument action levels (Section 5) exceeded. | • New information indicating that situation is less hazardous than originally thought.<br>• Change in site conditions that decreases the hazard.<br>• Change in work task that will reduce contact with hazardous materials. |

[a] Modifications are as indicated. CH2M HILL will provide PPE only to CH2M HILL employees.

[b] No facial hair that would interfere with respirator fit is permitted.

[c] Hardhat and splash-shield areas are to be determined by the SSC.

[d] Ear protection should be worn when conversations cannot be held at distances of 3 feet or less without shouting.

[e] Cartridge change-out schedule is at least every 8 hours (or one work day), except if relative humidity is > 85%, or if organic vapor measurements are > midpoint of Level C range (refer to Section 5)--then at least every 4 hours. If encountered conditions are different than those anticipated in this HSP, contact the HSM.

[f] Performing a task that requires an upgrade to a higher level of protection (e.g., Level D to Level C) is permitted only when the PPE requirements have been approved by the HSM, and an SSC qualified at that level is present.

# 5 Air Monitoring/Sampling

(Reference CH2M HILL SOP HS-207 - *Exposure Assessment for Airborne Chemical Hazards)*

## 5.1 Air Monitoring Specifications

| Instrument | Tasks | Action Levels[a] | | Frequency [b] | Calibration |
|---|---|---|---|---|---|
| **FID:** OVA model 128 or equivalent | Geoprobe | <1 ppm<br>1 to 10 ppm<br>> 10 ppm | Level D<br>Level C<br>Evacuate work area and contact HSM | Initially and periodically during task | Daily |
| **PID:** OVM with 10.6eV lamp or equivalent | Geoprobe | <1 ppm<br>1 to 10 ppm<br>> 10 ppm | Level D<br>Level C<br>Evacuate work area and contact HSM | Initially and periodically during task | Daily |
| **CGI:** MSA model 260 or 261 or equivalent | Geoprobe | 0-10% :<br>10-25% LEL:<br>>25% LEL: | No explosion hazard<br>Potential explosion hazard<br>Explosion hazard; evacuate or vent | Continuous during advancement of boring or trench | Daily |
| **$O_2$Meter:** MSA model 260 or 261 or equivalent | Geoprobe | >25%[c] $O_2$:<br><br>20.9%[c] $O_2$:<br><19.5%[c] $O_2$: | Explosion hazard; evacuate or vent<br>Normal $O_2$<br>$O_2$ deficient; vent or use SCBA | Continuous during advancement of boring or trench | Daily |

[a] Action levels apply to sustained breathing-zone measurements above background.

[b] The exact frequency of monitoring depends on field conditions and is to be determined by the SSC; generally, every 5 to 15 minutes if acceptable; more frequently may be appropriate. Monitoring results should be recorded. Documentation should include instrument and calibration information, time, measurement results, personnel monitored, and place/location where measurement is taken (e.g., "Breathing Zone/MW-3", "at surface/SB-2", etc.).

[c] If the measured percent of $O_2$ is less than 10, an accurate LEL reading will not be obtained. Percent LEL and percent $O_2$ action levels apply only to ambient working atmospheres, and not to confined-space entry. More-stringent percent LEL and $O_2$ action levels are required for confined-space entry (refer to Section 2).

[d] Refer to SOP HS-10 for instructions and documentation on radiation monitoring and screening.

[e] Noise monitoring and audiometric testing also required.

## 5.2 Calibration Specifications

(Refer to the respective manufacturer's instructions for proper instrument-maintenance procedures)

| Instrument | Gas | Span | Reading | Method |
|---|---|---|---|---|
| **PID:** OVM, 10.6 or 11.8 eV bulb | 100 ppm isobutylene | RF = 1.0 | 100 ppm | 1.5 lpm reg T-tubing |
| **PID:** MiniRAE, 10.6 eV bulb | 100 ppm isobutylene | CF = 100 | 100 ppm | 1.5 lpm reg T-tubing |
| **PID:** TVA 1000 | 100 ppm isobutylene | CF = 1.0 | 100 ppm | 1.5 lpm reg T-tubing |
| **FID:** OVA | 100 ppm methane | 3.0 $\pm$ 1.5 | 100 ppm | 1.5 lpm reg T-tubing |
| **FID:** TVA 1000 | 100 ppm methane | NA | 100 ppm | 2.5 lpm reg T-tubing |
| **Dust Monitor:** Miniram-PDM3 | Dust-free air | Not applicable | 0.00 mg/m$^3$ in "Measure" mode | Dust-free area OR Z-bag with HEPA filter |
| **CGI:** MSA 260, 261, 360, or 361 | 0.75% pentane | N/A | 50% LEL $\pm$ 5% LEL | 1.5 lpm reg direct tubing |

## 5.3 Air Sampling

Sampling, in addition to real-time monitoring, may be required by other OSHA regulations where there may be exposure to certain contaminants. Air sampling typically is required when site contaminants include lead, cadmium, arsenic, asbestos, and certain volatile organic compounds. Contact the HSM immediately if these contaminants are encountered.

**Method Description**

None anticipated.

**Personnel and Areas**

Results must be sent immediately to the HSM. Regulations may require reporting to monitored personnel. Results reported to:

HSM: Michael Goldman/ATL
Other: Dan Young/NVR

# 6 Decontamination

(Reference CH2M HILL SOP HS-506, *Decontamination*)

The SSC must establish and monitor the decontamination procedures and their effectiveness. Decontamination procedures found to be ineffective will be modified by the SSC. The SSC must ensure that procedures are established for disposing of materials generated on the site.

## 6.1 Decontamination Specifications

**Personnel**

- Boot wash/rinse
- Glove wash/rinse
- Outer-glove removal
- Body-suit removal
- Inner-glove removal
- Respirator removal
- Hand wash/rinse
- Face wash/rinse
- Shower ASAP
- Dispose of PPE in municipal trash, or contain for disposal
- Dispose of personnel rinse water to facility or sanitary sewer, or contain for offsite disposal

**Sample Equipment**

- Wash/rinse equipment
- Solvent-rinse equipment
- Contain solvent waste for offsite disposal

**Heavy Equipment**

- Power wash
- Steam clean
- Dispose of equipment rinse water to facility or sanitary sewer, or contain for offsite disposal

## 6.2 Diagram of Personnel-Decontamination Line

No eating, drinking, or smoking is permitted in contaminated areas and in exclusion or decontamination zones. The SSC should establish areas for eating, drinking, and smoking. Contact lenses are not permitted in exclusion or decontamination zones.

Figure 6-1 illustrates a conceptual establishment of work zones, including the decontamination line. Work zones are to be modified by the SSC to accommodate task-specific requirements.

# 7 Spill-Containment Procedures

Sorbent material will be maintained in the support zone. Incidental spills will be contained with sorbent and disposed of properly.

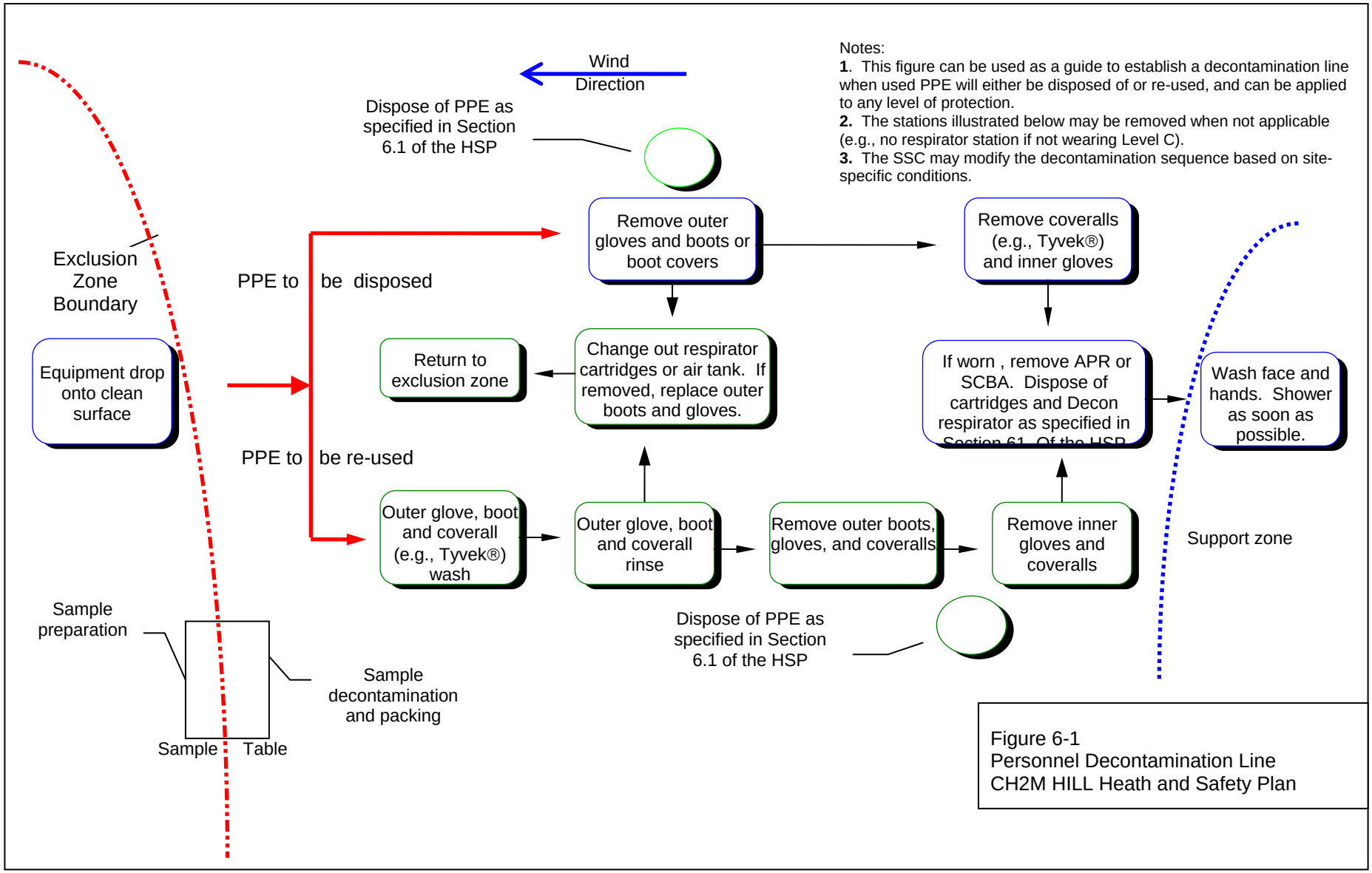


Figure 6-1
Personnel Decontamination Line
CH2M HILL Heath and Safety Plan

# 8 Site-Control Plan

## 8.1 Site-Control Procedures

(Reference CH2M HILL SOP HS-510, *Site Control)*

- The SSC will conduct a site safety briefing (see below) before starting field activities or as tasks and site conditions change.
- Topics for briefing on site safety: general discussion of Health and Safety Plan, site-specific hazards, locations of work zones, PPE requirements, equipment, special procedures, emergencies.
- The SSC records attendance at safety briefings in a logbook and documents the topics discussed.
- Post the OSHA job-site poster in a central and conspicuous location in accordance with CH2M HILL SOP HS-71, *OSHA Postings*.
- Establish support, decontamination, and exclusion zones. Delineate with flags or cones as appropriate. Support zone should be upwind of the site. Use access control at entry and exit from each work zone.
- Establish onsite communication consisting of the following:
  - Line-of-sight and hand signals
  - Air horn
  - Two-way radio or cellular telephone if available
- Establish offsite communication.
- Establish and maintain the "buddy system."
- Initial air monitoring is conducted by the SSC in appropriate level of protection.
- The SCC is to conduct periodic inspections of work practices to determine the effectiveness of this plan – refer to Sections 2 and 3. Deficiencies are to be noted, reported to the HSM, and corrected.

## 8.2 UXO Site Control

The UXO Technician II coordinates access control and security on site. Strict MEC avoidance procedures will be practiced during field investigation activities. An instrument-assisted visual site survey will be completed prior to commencing field sampling activities. Due to the hazardous nature of MEC work, only authorized personnel will be allowed in the exclusion zone (EZ). The EZ is the work site encompassing an area large enough to prevent personnel injuries from fragmentation and overpressure resulting from either an unintentional or intentional detonation of MEC.

During all intrusive operations (i.e., subsurface soil sampling) the EZ will be a radius of 200 feet minimum (2.36" rocket) (distance from DDESP TP-16, Chapter 4). If anything other than a 2.36" rocket is identified on-site, work will stop and the EZ re-evaluated. During UXO operations, only UXO trained or authorized essential personnel are allowed in the EZ. Authorized personnel are those that have completed the required training, meet medical requirements and are essential to the ongoing operation.

During all operations on site, the site UXO Technician II will cease operations if non-essential personnel are observed within the operating area (EZ). During duty hours, personnel will provide security at the site. Equipment will be returned to a designated area and secured at the end of each work day. Future site control measures to ensure safety are as follows;

- Eating, drinking and smoking are prohibited except in designated areas;
- MEC operations will cease if non-UXO trained or non-essential personnel are present;
- The UXO Technician II will escort all authorized visitors to the site;
- The UXO Technician II will maintain the site entry control log to ensure accurate accountability of personnel;
- The UXO Technician II will brief this UXO Avoidance Plan to all personnel entering the site to inform them of the potential site hazards. All personnel will acknowledge this briefing by signing the briefing log;
- In case of an emergency, personnel will exit the site and move to the designated safe area. The safe area will be located upwind of the site and outside of the fragmentation (400 feet) area. The UXO Technician

III will assist in determining the severity of the emergency. If the emergency warrants evacuation, the UXO Technician II will notify the Project Manager.

## 8.2 Hazwoper Compliance Plan

(Reference CH2M HILL SOP HS-220, *Site-Specific Written Safety Plans)*

Certain parts of the site work are covered by state or federal Hazwoper standards and therefore require training and medical monitoring. Anticipated Hazwoper tasks (Section 1.1.1) might occur consecutively or concurrently with respect to non-Hazwoper tasks. This section outlines procedures to be followed when approved activities specified in Section 1.1.2 do not require 24- or 40-hour training. Non-Hazwoper-trained personnel also must be trained in accordance with all other state and federal OSHA requirements.

- In many cases, air sampling, in addition to real-time monitoring, must confirm that there is no exposure to gases or vapors before non-Hazwoper-trained personnel are allowed on the site, or while non-Hazwoper-trained staff are working in proximity to Hazwoper activities. Other data (e.g., soil) also must document that there is no potential for exposure. The HSM must approve the interpretation of these data. Refer to subsections 2.5 and 5.3 for contaminant data and air sampling requirements, respectively.
- When non-Hazwoper-trained personnel are at risk of exposure, the SSC must post the exclusion zone and inform non-Hazwoper-trained personnel of the:
  - nature of the existing contamination and its locations
  - limitations of their access
  - emergency action plan for the site
- Periodic air monitoring with direct-reading instruments conducted during regulated tasks also should be used to ensure that non-Hazwoper-trained personnel (e.g., in an adjacent area) are not exposed to airborne contaminants.
- When exposure is possible, non-Hazwoper-trained personnel must be removed from the site until it can be demonstrated that there is no longer a potential for exposure to health and safety hazards.
- Remediation treatment system start-ups: Once a treatment system begins to pump and treat contaminated media, the site is, for the purposes of applying the Hazwoper standard, considered a treatment, storage, and disposal facility (TSDF). Therefore, once the system begins operation, only Hazwoper-trained personnel (minimum of 24 hour of training) will be permitted to enter the site. All non-Hazwoper-trained personnel must not enter the TSDF area of the site.

# 9 Emergency Response Plan

(Reference CH2M HILL, SOP HS-106, *Emergency Response*)

## 9.1 Pre-Emergency Planning

The SSC performs the applicable pre-emergency planning tasks before starting field activities and coordinates emergency response with CH2M HILL onsite parties, the facility, and local emergency-service providers as appropriate.

- Review the facility emergency and contingency plans where applicable.
- Determine what onsite communication equipment is available (e.g., two-way radio, air horn).
- Determine what offsite communication equipment is needed (e.g., nearest telephone, cell phone).
- Confirm and post emergency telephone numbers, evacuation routes, assembly areas, and route to hospital; communicate the information to onsite personnel.
- Field Trailers: Post "Exit" signs above exit doors, and post "Fire Extinguisher" signs above locations of extinguishers. Keep areas near exits and extinguishers clear.
- Review changed site conditions, onsite operations, and personnel availability in relation to emergency response procedures.
- Where appropriate and acceptable to the client, inform emergency room and ambulance and emergency response teams of anticipated types of site emergencies.
- Designate one vehicle as the emergency vehicle; place hospital directions and map inside; keep keys in ignition during field activities.
- Inventory and check site emergency equipment, supplies, and potable water.
- Communicate emergency procedures for personnel injury, exposures, fires, explosions, and releases.
- Rehearse the emergency response plan before site activities begin, including driving route to hospital.
- Brief new workers on the emergency response plan.

The SSC will evaluate emergency response actions and initiate appropriate follow-up actions.

## 9.2 Emergency Equipment and Supplies

The SSC should mark the locations of emergency equipment on the site map and post the map.

| Emergency Equipment and Supplies | Location |
|---|---|
| 20 LB (or two 10-lb) fire extinguisher (A, B, and C classes) | Support Zone/Heavy Equipment |
| First aid kit | Support Zone/Field Vehicle |
| Eye Wash | Support & Decon Zone/Field Vehicle |
| Potable water | Support & Decon Zone/Field Vehicle |
| Bloodborne-pathogen kit | Support Zone/Field Vehicle |
| Additional equipment (specify): | |

## 9.3 Incident Response

In fires, explosions, or chemical releases, actions to be taken include the following:

- Shut down CH2M HILL operations and evacuate the immediate work area.
- Notify appropriate response personnel.
- Account for personnel at the designated assembly area(s).
- Assess the need for site evacuation, and evacuate the site as warranted.

Instead of implementing a work-area evacuation, note that small fires or spills posing minimal safety or health hazards may be controlled.

## 9.4 Emergency Medical Treatment

The procedures listed below may also be applied to non-emergency incidents. Injuries and illnesses (including overexposure to contaminants) must be reported to Human Resources. If there is doubt about whether medical treatment is necessary, or if the injured person is reluctant to accept medical treatment, contact the CH2M HILL medical consultant. During non-emergencies, follow these procedures as appropriate.

- Notify appropriate emergency response authorities listed in Section 9.8 (e.g., 911).
- The SCC will assume charge during a medical emergency until the ambulance arrives or until the injured person is admitted to the emergency room.
- Prevent further injury.
- Initiate first aid and CPR where feasible.
- Get medical attention immediately.
- Perform decontamination where feasible; lifesaving and first aid or medical treatment take priority.
- Make certain that the injured person is accompanied to the emergency room.
- When contacting the medical consultant, state that the situation is a CH2M HILL matter, and give your name and telephone number, the name of the injured person, the extent of the injury or exposure, and the name and location of the medical facility where the injured person was taken.
- Report incident as outlined in Section 9.7.

## 9.5 Evacuation

- Evacuation routes and assembly areas (and alternative routes and assembly areas) are specified on the site map.
- Evacuation route(s) and assembly area(s) will be designated by the SSC before work begins.
- Personnel will assemble at the assembly area(s) upon hearing the emergency signal for evacuation.
- The SSC and a "buddy" will remain on the site after the site has been evacuated (if safe) to assist local responders and advise them of the nature and location of the incident.
- The SSC will account for all personnel in the onsite assembly area.
- A designated person will account for personnel at alternate assembly area(s).
- The SSC will write up the incident as soon as possible after it occurs and submit a report to the Corporate Director of Health and Safety.

## 9.6 Evacuation Signals

| Signal | Meaning |
|---|---|
| Grasping throat with hand | Emergency-help me. |
| Thumbs up | OK; understood. |
| Grasping buddy's wrist | Leave area now. |
| Continuous sounding of horn | Emergency; leave site now. |

## 9.7 Incident Notification and Reporting

- Upon any project incident (fire, spill, injury, near miss, death, etc.), immediately notify the PM and HSM. Call emergency beeper number if HSM is unavailable.
- For CH2M HILL work-related injuries or illnesses, contact and help Human Resources administrator complete an Incident Report Form (IRF). IRF must be completed within 24 hours of incident.
- For CH2M HILL subcontractor incidents, complete the Subcontractor Accident/Illness Report Form and submit to the HSM.
- Notify and submit reports to client as required in contract.

# 10 Approval

This site-specific Health and Safety Plan has been written for use by CH2M HILL only. CH2M HILL claims no responsibility for its use by others unless that use has been specified and defined in project or contract documents. The plan is written for the specific site conditions, purposes, dates, and personnel specified and must be amended if those conditions change.

## 10.1 Original Plan

**Written By:** **Kyra Donnell/ORO** **Date:** **Dan Young/NVR**

---

**Approved By: Michael Goldman** **Date:**

---

## 10.2 Revisions

**Revisions Made By:** **Date:**

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**Revisions to Plan:**

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**Revisions Approved By:** **Date:**

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# 11 Attachments

Attachment 1: Employee Signoff Form – Field Safety Instructions
Attachment 2: Project-Specific Chemical Product Hazard Communication Form
Attachment 3: Chemical-Specific Training Form
Attachment 4: Emergency Contacts
Attachment 5: Project H&S Forms/Permits
Attachment 6: Project Activity Self-Assessment Checklists
Attachment 7: Applicable Material Safety Data Sheets

# EMPLOYEE SIGNOFF FORM

## Health and Safety Plan

- The CH2M HILL project employees and subcontractors listed below have been provided with a copy of this HSP, have read and understood it, and agree to abide by its provisions.

**Project Name**: CLEAN III CTO-109 / MCB Camp Lejeune, Site UXO-08 **Project Number:** 330966

| EMPLOYEE NAME (Please print) | EMPLOYEE SIGNATURE | COMPANY | DATE |
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# Project-Specific Chemical Product Hazard Communication Form

This form must be completed prior to performing activities that expose personnel to hazardous chemicals products. Upon completion of this form, the SSC shall verify that training is provided on the hazards associated with these chemicals and the control measures to be used to prevent exposure to CH2M HILL and subcontractor personnel. Labeling and MSDS systems will also be explained.

**Project Name**: CLEAN III CTO-109 / MCB Camp Lejeune, Site UXO-08 **Project Number:** 330966

**MSDSs will be maintained at the following location(s):**

## Hazardous Chemical Products Inventory

| Chemical | Quantity | Location | MSDS Available | Container labels | |
|---|---|---|---|---|---|
| | | | | Identity | Hazard |
| Methane | 1 liter, compressed | Support Zone | | | |
| Isobutylene | 1 liter, compressed | Support Zone | | | |
| Pentane | 1 liter, compressed | Support Zone | | | |
| Hydrochloric acid | < 500 ml | Support Zone / sample bottles | | | |
| Nitric acid | < 500 ml | Support Zone / sample bottles | | | |
| Sulfuric Acid | < 500 ml | Support Zone / sample bottles | | | |
| Sodium hydroxide | < 500 ml | Support Zone / sample bottles | | | |
| Methanol | < 1 Gallon | Support/Decon Zones | | | |
| Hexane | < 1 Gallon | Support/Decon Zones | | | |
| pH buffers | < 500 ml | Support Zone | | | |
| MSA Sanitizer | < 1 liter | Support/Decon Zones | | | |
| Alconox/Liquinox | < 1liter | Support/Decon Zones | | | |
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Refer to SOP HS-05 *Hazard Communication* for more detailed information.

CH2MHILL

# CHEMICAL-SPECIFIC TRAINING FORM

| | |
|---|---|
| Location: | Project #: 330966 |
| HCC: | Trainer: |

**TRAINING PARTICIPANTS:**

| NAME | SIGNATURE | NAME | SIGNATURE |
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**REGULATED PRODUCTS/TASKS COVERED BY THIS TRAINING:**

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The HCC shall use the product MSDS to provide the following information concerning each of the products listed above.

☐ Physical and health hazards

☐ Control measures that can be used to provide protection (including appropriate work practices, emergency procedures, and personal protective equipment to be used)

☐ Methods and observations used to detect the presence or release of the regulated product in the workplace (including periodic monitoring, continuous monitoring devices, visual appearance or odor of regulated product when being released, etc.)

Training participants shall have the opportunity to ask questions concerning these products and, upon completion of this training, will understand the product hazards and appropriate control measures available for their protection.

Copies of MSDSs, chemical inventories, and CH2M HILL's written hazard communication program shall be made available for employee review in the facility/project hazard communication file.

**EMERGENCY CONTACTS**

If an injury occurs, notify the injured person's personnel office as soon as possible after obtaining medical attention for the injured person. Notification MUST be made within 24 hours of the injury.

## 24-hour CH2M HILL Emergency Beeper – 888/444-1226

**Medical Emergency – 911 or**
Hospital ER (On-Base) #: (910) 451-4840
(910) 451-4841
(910) 451-4842
Onslow County ER (Off-Base) #: (910) 577-2240
Ambulance (On-Base) #: (910) 451-3004
(910) 451-3005
Ambulance (Public) #: (910) 451-9111
LEPC (Poison Control)#: (800) 222-1222

**CH2M HILL Medical Consultant**
Dr. Peter Greaney
GMG WorkCare, Orange, CA
800/455-6155
(After hours calls will be returned within 20 minutes)

**Fire/Spill Emergency – 911 or**
Base Fire Response #: (910) 451-9111

**Local Occupational Physician**
Occupational Medicine Specialists
4815 Oleander Dr.
Wilmington, NC 28403
910 452-1111

**Security & Police – 911 or**
Base Security #: (910) 451-2555

**Corporate Director Health and Safety**
Name: Mollie Netherland/SEA
Phone: 206/453-5005
**24-hour emergency beeper: 888-444-1226**

**On-Scene Coordinator**
Name: Fire Chief
Phone: (910) 451-5815

**Environmental Management Division (EMD)**
Names: Bob Lowder
Phone: (910) 451-9607

**Utilities Emergency**
Water:
Gas: Contact Base EMD
Electric:

**Health and Safety Manager (HSM)**
Name: Michael Goldman/ATL
Phone: (770) 604-9182 x 396

**Designated Safety Coordinator (DSC) see Site-Specific HASP**
Name:
Phone:

**Regional Human Resources Department**
Name: Mary Jo Jordan/GNV
Phone: 352/355-2867

**Project Manager see Site-Specific HASP**
Name:
Phone:

**Corporate Human Resources Department**
Name: John Monark/COR
Phone: 303/771-0900

**Federal Express Dangerous Goods Shipping**
Phone: 800/238-5355

**CH2M HILL Emergency Number for Shipping Dangerous Goods**
Phone: 800/255-3924

**Worker's Compensation and Auto Claims**
Sterling Administration Services
Phone: 800/420-8926 After hours: 800/497-4566

Report fatalities AND report vehicular accidents involving pedestrians, motorcycles, or more than two cars.

Contact the Project Manager. Generally, the Project Manager will contact relevant government agencies.

**Facility Alarms:** TBD

**Evacuation Assembly Area(s):** TBD by the SC-HW; will probably be the local hotel where the field team is staying

**Facility/Site Evacuation Route(s):** follow main roads towards access gates and off the Base

**Route to Hospital: (Depends on location within base area (refer to attached Figures 12-1 and 12-2)**

**Nearest On-Base hospital:**
Base Naval Hospital (only to be used in extreme emergency)
Building NH100
100 Brewster Blvd.
Camp Lejeune, NC 28547
Phone: (910) 451-4840, (910) 451-4841, (910) 451-4842

**Local hospital:**
Onslow County Memorial Hospital
317 Western Boulevard
Jacksonville, NC 28546
Phone: (910) 577-2240

**Local ambulance service:**
Base Ambulance: (910) 451-3004, (910) 451-3005
Public Ambulance: (910) 451-9111

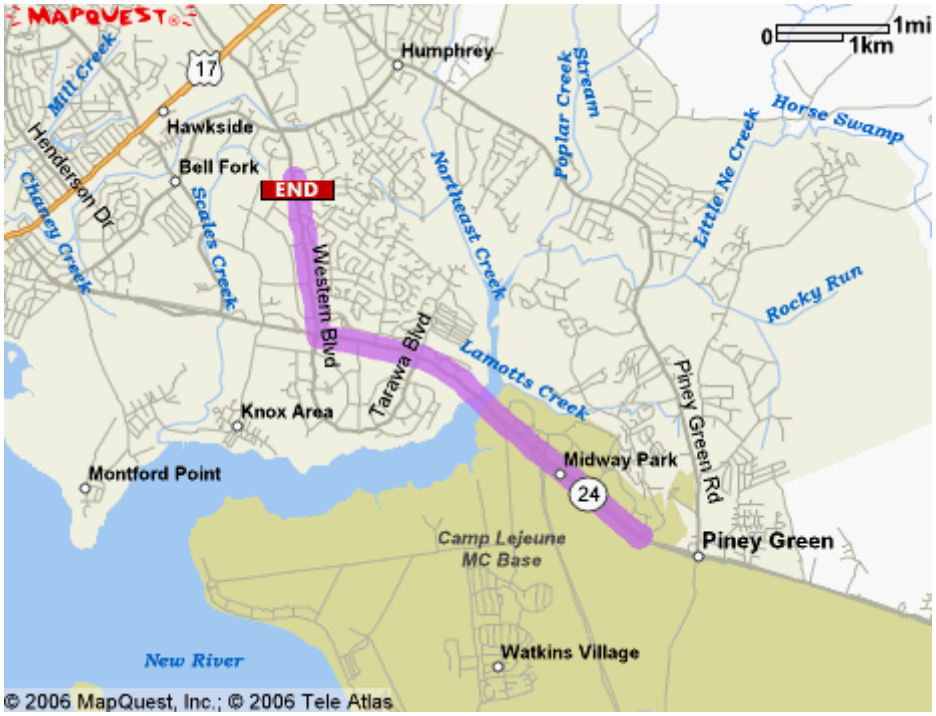
## From MCB Camp Lejeune

Directions to the Base Naval Hospital (Building NH100)
(nearest hospital; only to be used in an extreme emergency)

1. Proceed north to Holcomb Boulevard (towards Highway 24).
2. Turn left onto Brewster Boulevard (heading west)
3. Continue on Brewster Boulevard until intersection with the driveway to the Naval Hospital.
4. Turn onto Hospital driveway, and proceed to emergency room.

Directions to Onslow County Memorial Hospital :

1. From Holcomb Boulevard, exit Base through main gate.
2. Follow Highway 24 west until intersecting with Western Boulevard.
3. Turn right onto Western Boulevard.
4. The Onslow County Memorial Hospital is on the left, approximately 2 miles (fifth stop light) from Highway 24.
5. Follow the signs to the emergency room.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Northeast Creek
Poplar Creek
Stream
Horse Swamp
Little Ne Creek
Rocky Run
Lamotts Creek
Piney Green Rd
Knox Area
Midway Park
Montford Point
24
Camp Lejeune
MC Base
Piney Green
Watkins Village
New River
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# CH2M HILL HEALTH AND SAFETY PLAN

## Attachment 5

**Project H&S Forms and Permits**

**To be completed as needed for task specific operations.**

# CH2M HILL HEALTH AND SAFETY PLAN

## Attachment 6

## Project Activity Self-Assessment Checklists

# CH2M HILL HEALTH AND SAFETY PLAN

## Attachment 7

## Applicable Material Safety Data Sheets

# Appendix C
# Geophysical Investigation Plan

# Final

# Geophysical Investigation Plan

# Site Inspection at
# Site UXO-08
# Bazooka Range and Gas Chambers

# Marine Corps Base Camp Lejeune
# Jacksonville, North Carolina

**Contract Task Order 0109**

**October 2006**

Prepared for

**Department of the Navy**
**Naval Facilities Engineering Command**
**Atlantic Division**

Under the

**CLEAN III Program**
**Contract No. N62470-02-D-3052**

Prepared by


**Herndon, Virginia**

**APPENDIX C**

# Geophysical Investigation Plan

This GIP provides details of the equipment, approach, methods, operational procedures and quality control to be used in performing the geophysical investigations at Navy Munitions Response Program (MRP) Site UXO-08. The following topics are covered in the GIP subsections: safety issues; geophysical data quality objectives (DQOs); description of the site; anticipated MEC types, quantities, compositions, and depths; site physical conditions (e.g., geology and topography); adverse geophysical conditions; site utilities and manmade features that may affect the geophysical operation; data acquisition and reporting; and geophysical program QC requirements.

## C.1 Geophysical Operations Overview

Geophysical instruments will be used during DGM survey operations. DGM operations use instruments that record instrument response digitally, allowing for the subsequent download and interpretation of the data. DGM instruments will be operated by the DGM subcontractor.

## C.2 Safety Issues

Because MEC and MPPEH items may be present in the survey area, DGM survey personnel are prohibited from touching, handling, moving, or investigating any item that resembles MEC or MPPEH. Although discovery of MEC or MPPEH on this project is not anticipated, in the event that such an item is discovered and no UXO-qualified personnel are present, survey personnel will conspicuously mark and secure a perimeter around the item and evacuate the area while immediately contacting the CH2M HILL Site Manager. The CH2M HILL Site Manager will immediately notify the Base Explosive Ordnance Detachment (EOD) and the CH2M HILL Project Manager. DGM survey personnel should not remain within 200 feet of any suspected MEC or MPPEH item.

Personnel will be required to adhere to the project Health and Safety Plan (refer to Appendix B of this WP).

## C.3 DGM Personnel Qualifications

DGM operations will be conducted by personnel experienced in MEC geophysical operations and led by a qualified MEC geophysicist. All DGM support personnel onsite will have documentation of 40-hour Occupational Safety and Health Administration (OSHA) certification, any necessary re-certification (8-hour refresher), and OSHA-compliant medical monitoring physical exams. Throughout DGM operations, DGM support personnel will strictly adhere to the general practices given in this WP and specifically in the project Health and Safety Plan (refer to Appendix B of this WP).

## C.4 Area to be Investigated

The site consists of approximately 144 acres located in the Hadnot Point area of the base. It is bounded by Holcomb Boulevard to the northwest, McHugh Boulevard to the southwest, and Louis Road to the southeast. To the northeast, the site is bounded by the portion of the suspected bazooka range firing fan that extends northeastward past Gum Street to a point near the intersection of East Road and Elm Street. The site boundaries are shown on Figure C-1.

Site UXO-08 consists of the suspected former Lejeune Cantonment Bazooka Range, D-7 Gas Chamber, and Base CS Chamber and NBC (Nuclear, Biological, and Chemical) Trail (URS Corp., 2002). A 15-acre military construction (MILCON) project is planned within Site UXO-08. The MILCON construction footprint will be subjected to geophysical survey under a separate Construction Support Work Plan. Available open areas in the remaining 129 acres of Site UXO-08 will be subjected to geophysical survey covering a total area of 59 acres (45 acres using towed-array methods and 14 acres using single-coil manually-towed methods). The actual investigation locations will be based on site conditions.

The existing Parade Grounds, officially designated as W.P.T. Hill Field, are located within Site UXO-08 along the southeastern side of Holcomb Boulevard). The Parade Grounds are an expansive lawn used for ceremonies, receptions, parades, and other formal assemblies. It also hosts community gatherings, open-air concerts, including those by Camp Lejeune's 2d Marine Division Band, and athletic activities. W.P.T. Hill Field frequently serves as a helicopter landing zone for both administrative and tactical helicopter lifts (Camp Lejeune website, 2005). The Parade Grounds are surrounded on all four sides by industrial and administrative areas of the base.

The primary land use within Site UXO-08 consists of industrial and administrative areas. The eastern and northeastern portions of the site are primarily industrial and include the coal power plant and coal yard, while areas to the west and south-west are primarily administrative in nature.

## C.5 Past, Current, and Future Site Uses

Land planning for the Hadnot Point area began in late April 1941. The area was to contain the permanent administrative, housing, and subsistence buildings for the 1stMarDiv and was purchased under the name Area D (Louis Berger Group, 2002). At the time of purchase in November 1941 and September 1942, the land tracts contained structures such as a school, cabins, cribs, smokehouses, stables, and barns (Dept of the Navy, November 1941, September 1942).

Following the acquisition of the Parade Ground Area portions of Area D, athletic fields were constructed on the land that now makes up the Parade Ground Area and surrounding field. The athletic fields were located on the east side of Holcomb Boulevard, opposite the Post Administration Building, and encompassed a parade ground, four baseball diamonds and a football stadium with a quarter mile track around it. The boundaries then were the same as they are now, with the area being bounded by Holcomb Boulevard on the west, Gum Street on the north, McHugh Boulevard on the south, and Louis Road on the east.

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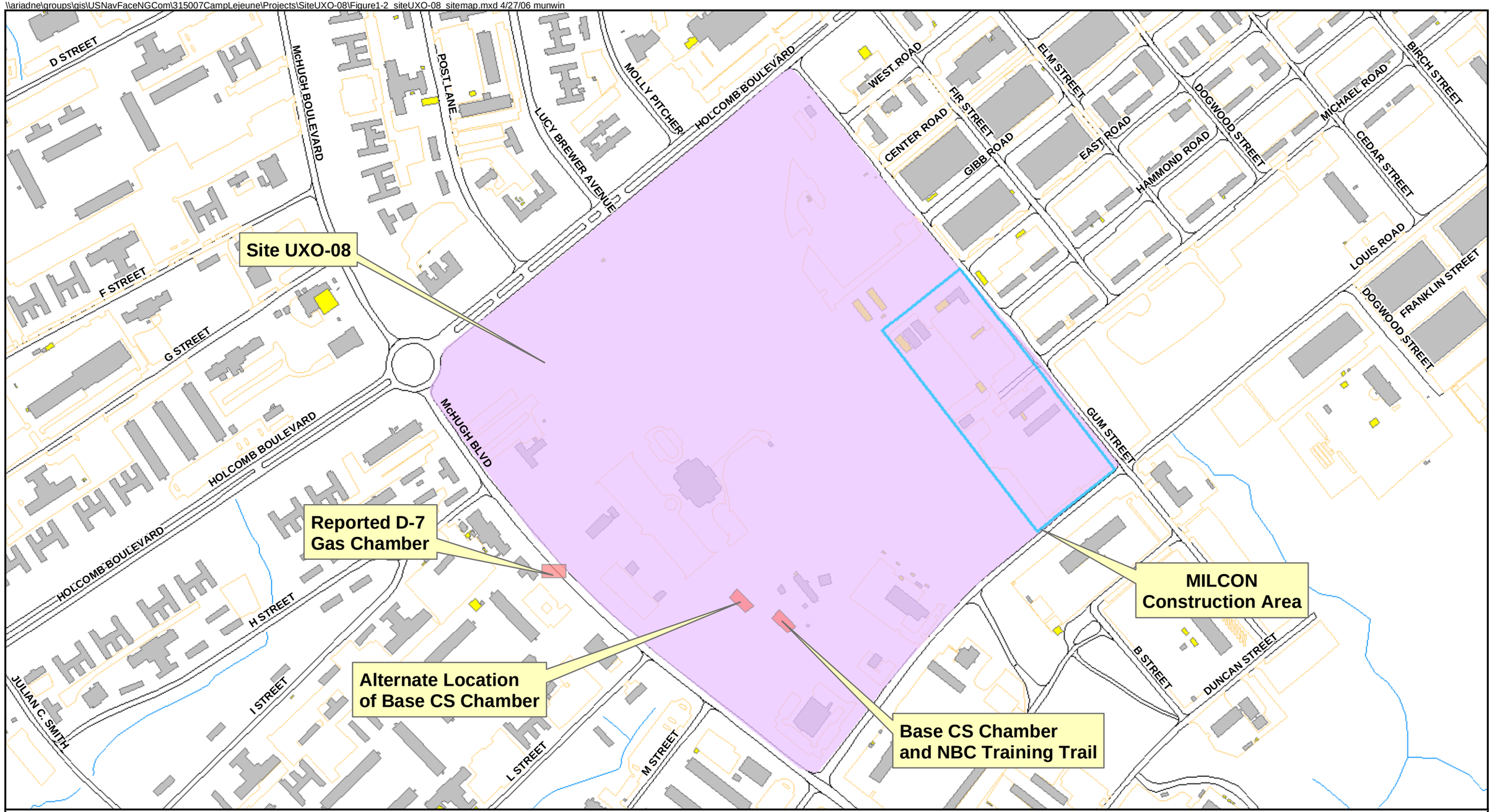


**Legend**

- PA/SI Work Area (Parade Ground Area)
- MILCON Construction Area
- Gas Chambers
- Buildings
- Vehicle Parking Area
- Road Area

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Meters

Figure C-1
Site UXO-08 Site Map
Camp Lejeune, North Carolina

CH2MHILL

A 1943 map of the area shows the football field, baseball diamonds and eight other buildings, including the base heating plant (refer to Attachment 2 of Appendix A). To the north was the supply and industrial area, extending from Gum Street to Ash Street. Railroad tracks that brought coal to the heating plant ran through the length of the industrial area. On the western side of Holcomb Boulevard, from Molly Pitcher Drive to Main Service Road (now named McHugh Boulevard) was the Women's Reserve area, an administrative area that included the Post Headquarters. Regimental Areas 1-5 were located south of McHugh Boulevard. Historical photographs depict the area as it looked in 1944 and 1948 (see Photographs 1 and 2 in Attachment 2 or Appendix A).

A 1954 map of historical features shows the area largely unchanged except for some additional buildings. Of note are the addition of the Field House (Building 751), used for recreational purposes and the Base CS Chamber and NBC (Nuclear, Biological, and Chemical) Trail. The location of the chamber and trail are shown on Figure C-1. The CS Chamber was located about 200 meters east of the Field House and was used to simulate chemical exposure scenarios. The Training Trail shows the decontamination procedures soldiers were required to conduct before they could leave the facility. The Base CS Chamber and the NBC Trail were also documented in the Range Identification and Preliminary Assessment Report (USACE, 2001), which listed the following agents, chemical agent simulants, and munitions as having reportedly been used at this location:

- CS (O-Chlorobenzylidenemalononitrile, a non-lethal riot control agent)
- Simulants Chemical Agent PEG 200 (polyethylene glycol)
- Training Set, Chemical Agent Identification, Simulants M72A1/A2
- Blister Agent Simulant, Molasses Residuum,
- Training Ammunitions (i.e., tear gas grenades, etc.)
- Atomic Explosion Simulator DVC 39-1
- Atomic Simulator (fabricated locally IAW FM 30-101)
- Artillery Simulator, M110.

No information is available to provide an estimated quantity of usage. The facility is estimated to have been in use from 1985 to 1987 (US Army Corp of Engineers, 2001, Duane Richardson, 2005).

A 1964 map shows that the recreational areas remained along with the parade ground. Additional industrial buildings on the northern end of the field and in the vicinity of the Base CS Chamber are also visible on the map.

The Range Identification and Preliminary Assessment Report (USACE, 2001) identified a second gas chamber in the site area, the D7 Gas Chamber located at Building 756. The gas chamber is estimated to have been in use from 1953 to 1961 and to have used only tear gas (USACE, 2001). The reported D7 Gas Chamber location is shown on Figure C-1.

The 2002 Range Inventory Report (URS Corp., 2002) reiterates previous findings of the presence of a tear-gas gas chamber and mentions the D-7 gas chamber, but does not verify the former location. In addition, the report indicates the presence of a suspected firing range, designated as the Lejeune Cantonment 2.36-in. Bazooka Range on the main cantonment area along with the D7 gas chamber. The ASR Report describes historical Explosive Ordnance Disposal (EOD) responses to inert practice 2.36" Bazooka rounds in the

1970s and 1990s in the vicinity of the reported Bazooka Range range fan. Personnel interviews have failed to confirm the former use of the project site as an established range. While ordnance is likely to be found in any given area of the base, the likelihood of W.P.T. Field having been used as a range is thought to be low due to its close proximity to the main administrative and industrial area of the base.

## C.6 Anticipated MEC Types, Composition, and Quantities

Anticipated MEC at the site includes 2.36" Rocket rounds, as documented in the archives search report (refer to Work Plan Appendix A).

## C.7 Anticipated Depth of MEC Items

The anticipated depth of potential MEC items is anywhere from near-surface to < 1 ft, based on EM1110-1-4009 penetration calculations for an M6A1 2.36" Rocket.

## C.8 Vegetation and Topography

The PA/SI work area is dominantly a flat area with surface elevation at 25 feet above mean sea level (msl). Much of the work area is covered with buildings, streets, parking lots, trees and other urban features. Properties surrounding buildings are mowed. Other than the physical structures, there are no apparent topography issues that might significantly impede geophysical operations at the site.

## C.9 Geologic Conditions

Shallow soil conditions are generally uniform throughout the PA/SI work area. In general, the shallow soils consist of unconsolidated deposits of silty and clayey-sand, silt, and clay. These soils represent the Quaternary age "undifferentiated" Formation which characterizes the shallow water table aquifer. Sands are fine to coarse-grained and contain varied amounts of silt (5 percent to 50 percent) and clay (5 percent to 20 percent). Results of the standard penetration tests (commonly referred to as "blow counts", ASTM 1586) indicate that the sands have a relative density of loose to dense. Based on field observations, the sands classify as SM and/or SC according to the Soil Conservation Survey (SCS). Clays are plastic to nonplastic, contain varied amounts of silt (some of which contained organic matter) and clay (5 percent to 25 percent), and classify as CL or CH. Standard penetration results for cohesive soils (silts and clays) indicate a relative density of medium dense to stiff.

The local geology (interlayered, unconsolidated sediment) is amenable to either magnetics or electromagnetic detection techniques; however, because the items of interest are small (hand grenades), the magnetics technique will not be considered for use as it has been shown at multiple MEC sites to be less effective for finding smaller items at shallow depths than electromagnetic detection techniques. No geologic conditions that will impede geophysical operations at the site are known.

## C.10 Shallow Groundwater Conditions

Groundwater is anticipated to be relatively shallow, ranging from within approximately 10 feet below ground surface; however, the 2.36 inch Rocket Rounds are likely to be within the top foot below the ground surface. Additionally, the only MEC anticipated to be below 1-2 feet below ground surface would be those placed in disposal pits.

## C.11 Adverse Geophysical Conditions

No geophysical conditions at Site UXO-08, other than those discussed under Section C.12 (Site Utilities), that might interfere with electromagnetic near-surface geophysical instrument operation are anticipated.

## C.12 Site Utilities

Overhead and underground utilities are present within Site UXO-08.

## C.13 Manmade Features Potentially Affecting Geophysical Operations

The area subjected to geophysical surveying is comprised of 59 acres selected from within the 144-acre site. Though Site UXO-08 includes a number of buildings, parking lots, and other urban features, survey transects will be selected to attempt to mitigate potential affects to geophysical operations.

## C.14 Site-Specific Dynamic Events

No site-specific dynamic events (e.g., unusually strong winds, harsh weather conditions) that might affect the DGM survey operations at Site UXO-08 are anticipated. Although it is possible that weather conditions may impede operations at some time during the project, no significant delays or effects on geophysical instruments resulting from weather are expected.

## C.15 Overall Site Accessibility and Impediments

Buildings and pavement are the only known issues with respect to site access. Vegetation will prevent access to a large percentage of the site.

## C.16 Potential Worker Hazards

No potential worker hazards are apparent at Site UXO-08 other than those associated with conducting project fieldwork, which are addressed in the project Health and Safety Plan (refer to Work Plan Appendix B).

## C.17 Geophysical Prove-out

A site-specific GPO will be used to finalize project DQOs and validate the geophysical system selected for the DGM surveys. The GPO Work Plan is provided as Attachment 1 to this GIP.

## C.18 DGM Data Quality Objectives

The primary objective of the DGM activities at the site is to identify metallic anomalies that may be MEC or MPPEH. DQOs specific to the DGM surveys are identified in the GPO Work Plan (Attachment 1 to this GIP) and will carry through to the site surveys.

## C.19 Geophysical Instrumentation

The actual system configuration to be used for DGM operations at the site will be determined through the GPO process.

## C.20 Data Acquisition, Processing and Reporting

### C.20.1 Field Data Sheets

Field data sheets (paper or digitally recorded) will include, at a minimum, the following:

- Site ID
- Grid ID (or other identifier of surveyed area)
- Field team leader name
- Field team members' names
- Date of data collection
- Instrument used
- Positioning method used
- Instrument serial numbers
- File names in data recorders
- Data collection sampling rate
- Line numbers, survey direction, fiducial locations, start and end points
- Weather conditions
- Grid conditions
- Terrain conditions
- Cultural conditions
- Survey area sketch
- Associated QC data file names
- Field notes (other)

### C.20.2 Data Processing

Instrument-specific software will be used for initial data processing and the output will be imported into Geosoft Oasis Montaj™ (or comparable software if available) for additional

processing, graphical display, anomaly selections and QA/QC. Types of processing will be system specific, but the general processing steps that may be performed on the data include the following:

- Positional offset correction
- Sensor bias, background leveling and/or standardization adjustment
- Sensor drift removal
- Latency or lag correction
- Geophysical noise identification and removal (spatial, temporal, motional, terrain induced)
- Contour level selection with background shading
- Digital filtering and enhancement (low pass, high pass, band pass, convolution, correlation, non-linear, etc.)

### C.20.3 Interpretation/Anomaly Selection

MEC-experienced data processing geophysicists will use the following criteria, supplemented by site- and system-specific criteria established during the GPO, for selecting and locating anomalies:

- Maximum amplitude of the response with respect to local background conditions
- Lateral extent (plan size) of the area of response
- Three-dimensional shape of the response
- Location of the response with respect to the edge of the grid, unsurveyable areas, land features, cultural features, or utilities within or adjacent to the grid
- Shape and amplitude of the response with respect to the response of known targets buried in the GPO test plot
- Shape and amplitude of the response with respect to relevant anomalies encountered in previous MEC removal grids
- Potential distortions in the response due to interference from nearby cultural features

### C.20.4 Dig Sheets

The target analysis process culminates in the creation of dig sheets, which contain target information location, amplitude, and other distinguishing characteristics (e.g., depth and weight estimates) when possible. At a minimum, the following information will be provided on the dig sheets:

- Project site
- DGM contractor
- Responsible geophysicist
- Grid identification

- Unique anomaly identification numbers
- Predicted location in State Plane Coordinates in Easting (U.S. survey ft) and Northing (U.S. survey ft)
- Instrument peak value at each anomaly location

### C.20.5 Grid Maps

With each dig sheet, the DGM subcontractor will also provide a grid map, which contains the following:

- Client
- Project
- Contractor
- Map creator
- Map approver
- Date map was created
- Map file name (full path and file extension)
- Scale
- Grid or area identification
- Contoured data
- Anomaly locations with unique identification numbers
- North arrow, legend, title block, etc.

### C.20.6 Records Management

All files will be made available for QC verification during the project to verify that the field and data processing procedures are properly implemented. All raw data files, final processed data files, hard copies, and field notes will be maintained for the duration of the project.

### C.20.7 Final Reports, Maps, and Geophysical Mapping Data

No later than 3 work days after collection, the DGM subcontractor will provide each day's data for QC inspection via the Internet using a File Transfer Protocol (FTP) site, electronic mail (email) attachments for small files under 5 megabytes, or digital compact disk (CD). Such data are considered to be in raw form. These data will be corrected for sensor offsets, diurnal variations, latency, and drift. Also provided will be a digital planimetric map, in Geosoft format and coincident with the location of the geophysical survey, so that each day's geophysical data set can be registered within the original mission plan survey map.

All geophysical field data will be provided to CH2M HILL in delineated fields as x, y, z, v1, v2, and so on, where x and y are State Plane Coordinates in Easting (U.S. survey ft) and Northing (U.S. survey ft) directions, z (elevation is an optional field in feet), and v1, v2, v3, and so on are the instrument readings. The last data field will be a time stamp. Each data field will be separated by a comma or tab. No individual file may be more than 100 mega-bytes in size and no more than 600,000 lines long. Each grid of data will be logically and sequentially named so that the file name can be easily correlated with the grid name used by other project personnel.

Within 5 working days of data collection, the processed geophysical field data, all final maps, and supporting geophysical interpretations will be provided to CH2M HILL. All

geophysical data will be accompanied by a Microsoft®Word 6.0 or higher file documenting the field activities associated with the data and the processing performed. Required information is summarized in Table C-1.

TABLE C-1
Processing Documentation Requirements

| Information Type | "Raw" Data Delivery | Final Data Delivery | Must be in File Headers |
|---|---|---|---|
| Site ID | X | X | X |
| Geophysical instrument type used | X | X | X |
| Positioning method used | X | X | X |
| Instrument serial numbers (geophysical and positioning) | X | X | |
| Coordinate system and unit of measure | X | X | X |
| Grid ID (or other identifier of surveyed area) | X | X | X |
| Date of data collection | X | X | X |
| Raw data file names associated with delivery | X | X | X |
| Processed data file names associated with delivery | X | X | X |
| Name of Project Geophysicist | X | X | |
| Name of Site Geophysicist | X | X | |
| Name of data processor | X | X | X |
| Data processing software used | X | X | |
| Despiking method and details | X | X | |
| Sensor drift removal and details | X | X | |
| Latency correction and details | X | X | |
| Sensor bias, background leveling and/or standardization adjustment method and details | X | X | |
| Geophysical noise identification and removal (spatial, temporal, motional, terrain induced) and details | | X | |
| Other filtering/processing performed and details | | X | |
| Gridding method | | X | |
| Anomaly selection and decision criteria details | | X | |
| Other processing comments | | X | |
| Date data processing is completed | X | X | |
| Data delivery date | X | X | |
| Scanned copy of field notes and field mobile data collection device notes (if applicable) | X | | |

At the completion of the project, all project geophysical data described in this chapter will be collected, organized, and submitted to NAVFAC and MCB Camp Lejeune in a separate package that will be referenced in the After Action Report.

All sensor data will be correlated with navigational data based upon a local "third order" (1:5,000) monument or survey marker. If a suitable point is not available, a North Carolina-certified PLS will establish a minimum of two new monuments or survey markers per sector with a minimum of third-order accuracy.

## C.21 DGM Systems Quality Control

An extensive QC program will be applied to the DGM operations at Site UXO-08. Figure C-2 shows an overall chart of the QC steps, and details for those steps are provided in the following subsections.

## C.22 DGM Instruments Quality Control

Each of the geophysical systems will be field tested to confirm proper operating conditions. Several basic QC tests will be performed in addition to instrument-specific tests. A description of each basic QC test, its acceptance criteria, and its frequency is provided below and summarized in Table C-2.

1. **Equipment Warm-up**. This is an instrument-specific activity, although standard warm-up time is 5 minutes. Some geophysical systems require more warm-up time than others. Each system-specific SOP defines the equipment-specific warm-up time. Equipment warm-up will be performed the first time an instrument is turned on for the day or has been turned off for a sufficient amount of time for the specific instrument to cool down.

2. **Record Sensor Positions**. Positioning accuracy of the final processed data will be demonstrated by operating the equipment over one or more known points. The accuracy of the data positioning will be assessed by calculating the difference between a known location over which a positioning instrument is held and the displayed position. The sensor position test will be conducted at the beginning of the survey operation for each work day.

3. **Personnel Test.** This test checks the response of instruments to personnel and their clothing/proximity to the system. On a daily basis, the instrument coils/sensors for those instruments being used that day will be checked for their response to the personnel operating the system. The response will be observed in the field for immediate corrective action and transmitted back to the processor, and analyzed and checked for spikes in the data that can possibly create false anomalies. The personnel test will be conducted at the beginning of the survey operation for each work day.

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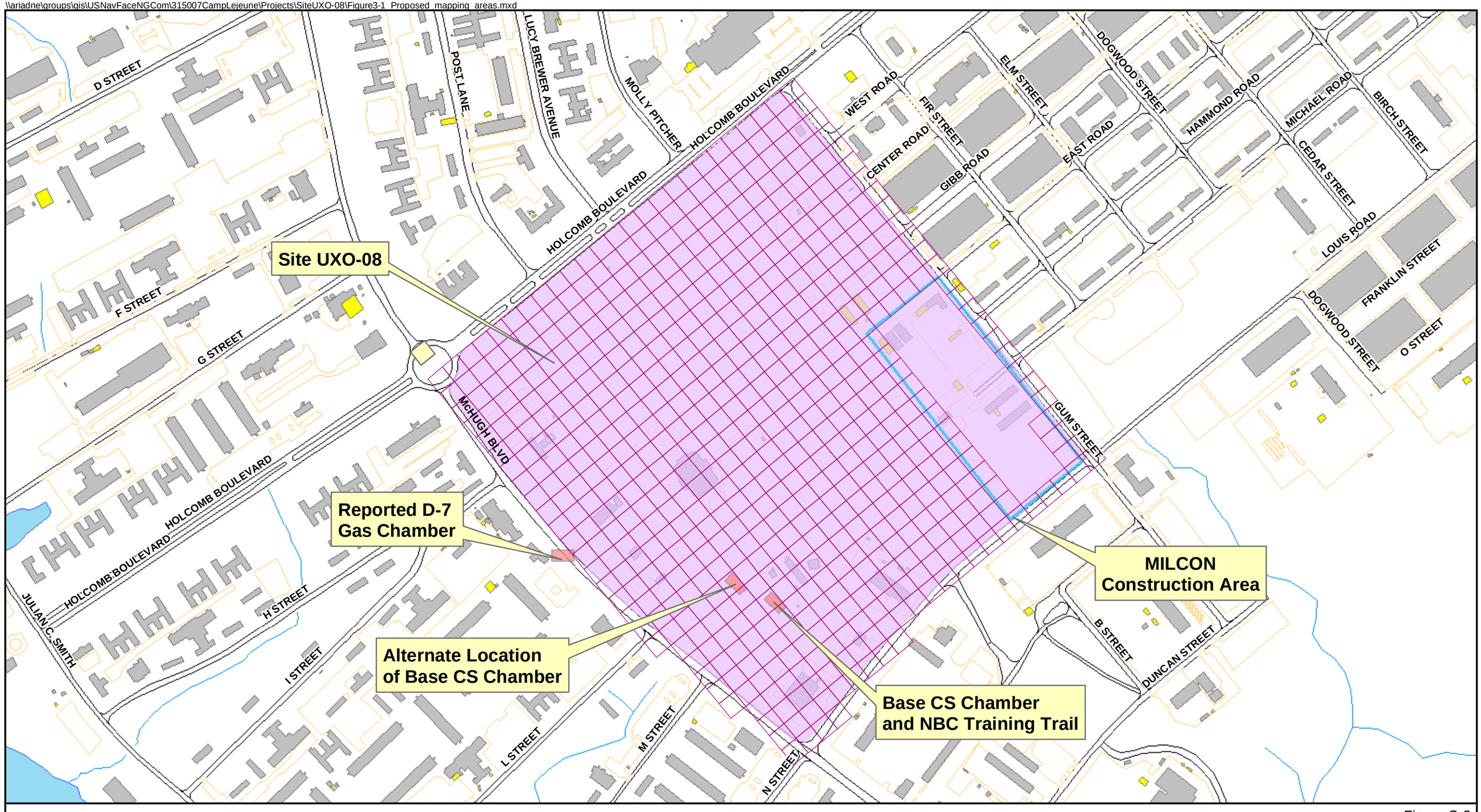



**Legend**

- PA/SI Work Area (Parade Ground Area)
- MILCON Construction Area
- Gas Chambers
- Buildings
- Vehicle Parking Area
- Road Area
- Towed Array
- Single Coil Manually-Towed

N
W E
S

0 150 300 Meters

0 100 200 400 600 Feet

Figure C-2
Digital Geophysical Mapping Grid Layout
Site UXO-08
Camp Lejeune, North Carolina

CH2MHILL

TABLE C-2
DGM Instruments Standardization Tests and Acceptance Criteria

| Test | Test Description | Acceptance Criteria | Power On | Beginning of Day | Beginning and End of Day | First Time Instr. Used | 2% of Total Area Surveyed |
|---|---|---|---|---|---|---|---|
| 1 | Equipment Warm-up | Equipment specific (typically 5 min) | X | | | | |
| 2 | Record Sensor Positions | ± 4 inch (2.54 cm) | | X | | | |
| 3 | Personnel Test | Based on instrument used. Personnel, clothing, etc. should have no effect on instrument response | | X | | | |
| 4 | Vibration Test (Cable Shake) | Data profile does not exhibit data spikes | | X | | | |
| 5 | Static Background & Static Spike | ± 20% of standard item response, after background correction | | | X | | |
| 6 | Six Line Test | Repeatability of response amplitude ± 20%, Positional Accuracy ± 20 cm | | | | X | |
| 7 | Repeat Data | Repeatability of response amplitude ± 20%, Positional Accuracy ± 20 cm | | | | | X |

4. **Vibration Test (Cable Shake).** This test checks the response of instruments to vibration. On a daily basis, the instrument coils/sensors for those instruments being used that day will be checked for their response to vibrations in the cables. The response will be observed in the field for immediate corrective action and transmitted back to the processor and analyzed and checked for spikes in the data that can possibly create false anomalies. The vibration test will be conducted at the beginning of the survey operation for each work day.

5. **Static Background and Static Spike**. Static tests will be performed by positioning the survey equipment within or near the survey boundaries in an area free of metallic contacts and collecting data for (minimally) a 1-minute period. During this time, the instrument will be held in a fixed position without a spike (known standard) and then with a spike. The purpose of the static test is to determine whether unusual levels of instrument or ambient noise exist. The static background and static spike test will be conducted at the beginning and end of each survey operation.

6. **Six Line Test.** The Six Line Test is a standard response test consisting of a predetermined route (survey line) established on or near the site in an area free of metallic contacts. The beginning, midpoint, and end of the line will be marked; data will be collected along the line. The line will be traversed a total of six times as follows: 1) *normal* data collection speed *without* a spike at the centerpoint; 2) *normal* data collection speed *without* a spike at the centerpoint; 3) *normal* data collection speed *with* a

spike at the centerpoint; 4) *normal* data collection speed *with* a spike at the centerpoint; 5) *fast* data collection speed *with* a spike at the centerpoint; 6) *slow* data collection speed *with* a spike at the centerpoint. (Speed of data collection will also be evaluated as part of the GPO analysis process.) The Six Line Test will be conducted the first time a system is used at the site.

7. **Repeat Data.** This test is performed to verify repeatability of the data and will be performed after the initial survey over an area. At least 2% of the survey lines will be repeated.

## C.23 Quality Control of DGM Data and Deliverables

Both the DGM subcontractor and CH2M HILL will perform QC of geophysical data and data deliverables at each step of the processing path. Figure C-3 shows the processing path and the QC steps performed. Data will not move to the next stage until they have passed the QC check.

The following items are among the QC checks performed on the field forms:

- Appropriate fields have been completed
- Field entries are appropriate for work performed
- Data required for geophysical data processors have been entered
- General editorial review (spelling, dates, etc.)

The following items are among the QC checks performed (as applicable to the particular data set) on the "Pre-processed Data":

- Data have been translated from local coordinates into the State Plane system
- Coordinates are correct (grids fall in correct locations when loaded into GIS)
- Line gaps have been accounted for
- Background geophysical noise is acceptable
- Crosstrack distances between lines are acceptable
- Downline data density is acceptable
- Appropriate file headers have been attached
- Files contain appropriate grids

The following items are among the QC checks performed (as applicable to the particular data set) on the "Processed Data":

- Latency/Lag correction is appropriate
- Despiking is appropriate
- Leveling is appropriate
- Filtering performed is appropriate
- Line breaking is appropriate
- Anomaly selections are appropriate

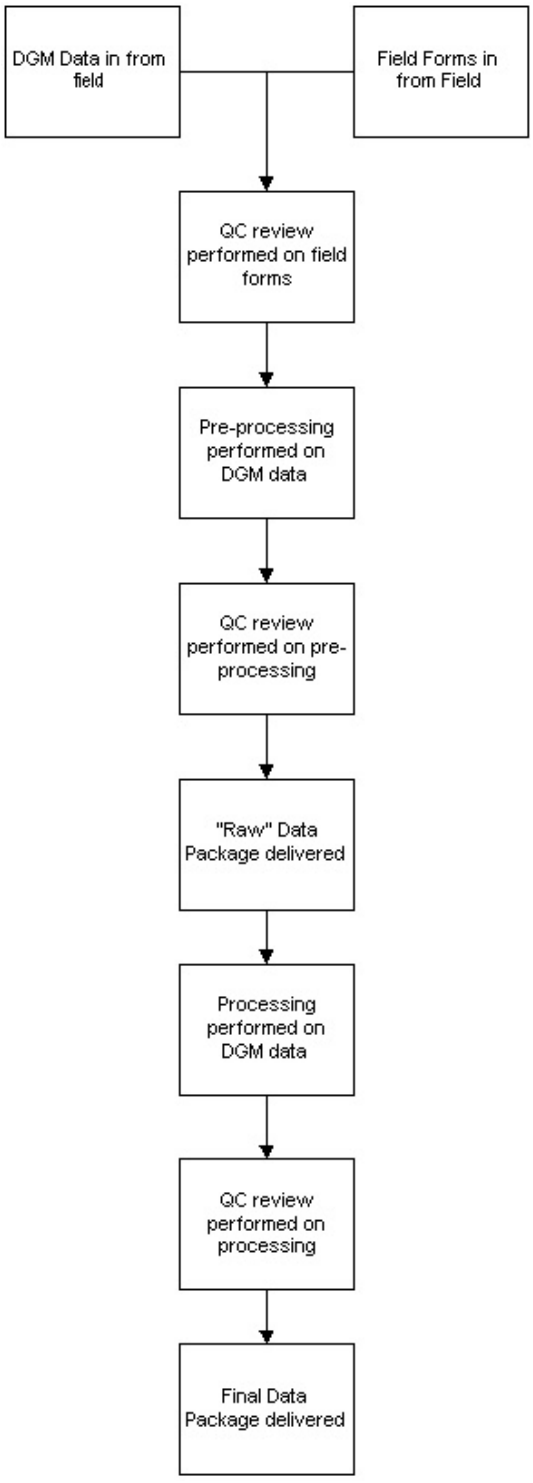



FIGURE C-3
QC of DGM Data – Process Flowpath

## C.24 Corrective Measures

Specific corrective measures are dependent on the type of geophysical equipment used; however, the following are the basic corrective measures to be followed in association with DGM surveying:

- Replacement of sensors if they fail to meet instrument check requirements.
- Resurvey of grids if seeded items are not identified (do not show in the DGM data). In a situation in which there is a failure to select a seed item from the data but the item is clearly present in the DGM data, a resurvey will not be performed, but instead a re-analysis of the DGM data.

# Attachment 1
# Geophysical Prove-Out Work Plan

# Final

# Geophysical Prove-Out Work Plan

# Site Inspection at
# Site UXO-08
# Bazooka Range and Gas Chambers

# Marine Corps Base Camp Lejeune
# Jacksonville, North Carolina

**Contract Task Order 0109**

**October 2006**

Prepared for

**Department of the Navy**
**Naval Facilities Engineering Command**
**Atlantic Division**

Under the

**CLEAN III Program**
**Contract No. N62470-02-D-3052**

Prepared by


**Herndon, Virginia**

# Contents

# Acronyms and Abbreviations

| | |
|---|---|
| cm | centimeters |
| DGM | Digital Geophysical Mapping |
| DGPS | Differential Global Positioning System |
| DID | Data Item Description |
| DQO | Data Quality Objective |
| FAR | False Alarm Rate |
| GPO | Geophysical Prove-Out |
| GPS | Global Positioning System |
| Mb | megabytes |
| MEC | Munitions and Explosives of Concern |
| QC | Quality Control |
| RLS | Registered Land Surveyor |
| RTK | Real-Time Kinematic |
| RTS | Robotic Total Station |
| SOP | Standard Operating Procedure |
| TDEM | Time Domain Electromagnetic |
| USACE | U.S. Army Corps of Engineers |

# 1.0 Purpose

CH2M HILL Inc. was awarded Contract Task Order No. 0109, Modification 02, under LANTDIV CLEAN III Program Contract No. N62470-02-D-3052 to conduct a Preliminary Assessment/Site Investigation (PA/SI) at Navy Munitions Response Program (MRP) Site UXO-08, MCB Camp LeJeune, North Carolina. This Geophysical Prove-Out (GPO) Plan documents the GPO activities to be performed as part of the process for validating the digital geophysical mapping (DGM) system to be utilized during the DGM activities.

The primary objective of the GPO is to demonstrate and document the site-specific capabilities of a DGM system to operate as an integrated system capable of meeting project data quality objectives (DQOs). For the purposes of this work, a system is considered to include the survey platform, sensors, navigation equipment, data analysis and management, and associated equipment and personnel. Additional objectives of the GPO include:

- Document the consideration given to various geophysical detection instruments, the criteria used to identify geophysical instruments for consideration, and the causes for their respective selection or rejection.
- Document the capabilities and limitations of the geophysical detection instrument selected for consideration.
- Observe the geophysical detection instrument operating in the DGM subcontractor's configuration, using their personnel and methodologies.
- Evaluate the DGM subcontractor's data collection, data transfer quality and data QC method(s).
- Evaluate the DGM subcontractor's method(s) of data analysis and evaluation.
- Establish anomaly selection criteria.

The GPO objectives will be attained through evaluation of the achievement of the DQOs (discussed below) and observation of the GPO activities by the CH2M HILL Project Geophysicist. A full discussion of the evaluation will be provided in the PA/SIn Report (see Section 9.0 for topics to be discussed).

# 2.0 Project Data Quality Objectives

DGM operations performed in the GPO area will demonstrate the ability of the tested system to achieve specific project DQOs. The project DQOs, measurement performance criteria, and test method to be used during the GPO are discussed in the following sub-sections and summarized in Table 1.

## 2.1 General Geophysical Systems Functioning

### 2.1.1 DGM Systems Positioning

The DQO for DGM systems positioning is that the coordinates being obtained from the positioning systems are at a sufficient enough accuracy to allow for appropriate relocation

of munitions and explosives of concern (MEC) items for intrusive investigation. The measurement performance criterion for this is that the positional error at known monuments will not exceed ±20 cm. This will be evaluated during the GPO by ensuring that, on a daily basis, the positioning system in use passes QC Test #2 (Record Sensor Positions), as outlined in Section 6.0.

### 2.1.2 DGM Systems Data Repeatability

The DQO for DGM systems data repeatability is that the systems respond consistently from the beginning to the end of an operation. The measurement performance criterion for this is that the response to a standardized item will not vary more than ±20%. This will be evaluated during the GPO by ensuring that, on a daily basis, the geophysical system being used passes QC Test # 5 (Static Background and Static Spike) and QC Test #7 (Repeat Data), as outlined in Section 6.0.

TABLE 1
Project Data Quality Objectives

| Data Quality Objective | Measurement Performance Criteria | Test Method During GPO |
|---|---|---|
| **General System Functioning** | | |
| Accurate coordinates are being obtained from DGM positioning systems. | Positional error at known monuments will not exceed ±20 cm. | Results of QC Test #2 (Record Sensor Positions) (see Section 6.0) will be evaluated to ensure compliance. |
| Repeatable data are being obtained from DGM system. | Response to standardized item will not vary more than ±20%. | Results of QC Test #5 (Static Background and Static Spike) (see Section 6.0) will be evaluated to ensure compliance. |
| **DGM Surveys** | | |
| DGM survey system can detect MEC to the depths specified by the following equation:<br>Estimated Detection Depth = 11*diameter<br>(Depth is to top of the item.)<br>Notes: This DQO will be modified for the production surveys based on the results of the GPO. Slight variations are considered acceptable for small MEC items (e.g. hand grenades, 20mm projectiles) as these are typically more difficult to detect with available technologies. | Sensor to identify 100% of all MEC items (or their surrogates in the GPO) at depths fitting within the detection depth equation ±20%. | Verify that:<br>All of the seed items fitting within the detection depth equation have anomalies selected from the DGM surveys within 1 meter of a point on the surface above the item. |
| Downline data density is sufficient to detect MEC items. | Over 98% of possible sensor readings are captured along a transect.<br>In addition, any transect containing a data gap of 2 ft or greater does not meet the DQO. | Results of DGM surveys with various systems and configurations will be evaluated to ensure compliance. |
| Coverage over survey area is sufficient to detect MEC items. | Search transect spacing to vary no more than ±20% of spacing specified in sampling design. | Results of DGM surveys with various systems will be evaluated to ensure compliance. |
| Positioning of detected anomalies is accurate. | 95% of all anomaly locations (as shown on the dig sheets) lie within a 1-meter radius of a point on the ground surface directly above the source of the anomaly. | Anomalies selected will be compared with known seed item locations to ensure compliance. |
| **Data Handling** | | |
| All data must be delivered in a timely manner and in a useable format. | Data packages (see Section 8) are completed and delivered to the CH2M HILL Project Geophysicist within 1 working day of data collection. | Evaluate based on actual delivery of data |

## 2.2 DGM Surveys

### 2.2.1 MEC Detection

The DQO for MEC detection is to detect all MEC to their maximum detectable depths. However, actual maximum detectable depths may vary based on site-specific and munitions-specific parameters, such as: 1) item orientation, 2) site background/noise levels, 3) masking effects from adjacent metallic items, 4) item shape, 5) magnetic conductivity of item materials, and 6) weathering effects on the magnetic conductivity of item materials.

An equation has been developed based on empirical data that describes typical detection depths for most MEC items (USACE DID FPRI-005-05.01):

**Estimated Detection Depth = 11*diameter**
(Depth is to top of the item.)

This relationship reflects the fact that MEC detection capability is reduced with greater item depth and/or decreased item size. The equation assumes worst-case orientations for ordnance items, a ratio of length to width of at least 2:1, and that the item is not thin-walled. Because of these assumptions, the formula is to be used only as a guiding point as opposed to a final metric. Slight variations are considered acceptable for small MEC items (e.g. hand grenades, 20mm projectiles) as these are typically more difficult to detect with available technologies. The GPO process will be used to determine an appropriate final MEC detection DQO for the site surveys.

A GPO plot was recently built at MRP Site UXO-04, Knox Trailer Park, MCB Camp Lejeune in similar types of soil and conditions as the area that is the subject of this investigation; therefore, the GPO will be performed at the existing plot. The items placed in the GPO plot were simulants of MK-II hand grenades and are smaller than the smallest suspected MEC (2.36" rockets) at this site. At least six inert 2.36" rockets (or simulants) will be buried at various depths and orientations to test the system's detection capabilities. The measurement performance criterion for this is that the system tested must identify 100 percent of all MEC items in the GPO at depths fitting within 20% of the detection depth equation. This will be evaluated by verifying that all of the seed items in this category have anomalies selected from the DGM surveys within 1 meter of a point on the surface above the item.

The actual project DQO for detection depth will be based on the depth and orientation that the item was detectable (using the signal-to-noise ratio, shape of the anomaly, and width of the anomaly for anomaly selection) without causing an unreasonable false alarm rate (FAR) using the same anomaly selection criteria. It should be noted that there is no absolute rule to determine an acceptable FAR. A high FAR may increase the possibility that the target items will be detected; however, the inefficiencies associated with a high FAR increase field efforts, data processing and handling, and the likelihood of errors; and may decrease the overall quality of the GPO and project fieldwork results.

### 2.2.2 Downline Data Density

The DQO for downline (along the survey transect) data density is to have sufficient data collected along each transect to detect MEC items. The measurement performance criterion for this is that at least 98 percent of possible sensor readings are captured along each

transect. In addition, any transect containing a data gap of 2 feet or greater does not meet the DQO. This will be evaluated during the GPO by verifying that all of the DGM data collected and used for anomaly selection meets this standard.

### 2.2.3 Survey Coverage (Lane Spacing)

The DQO for lane spacing is to maintain appropriate lane spacing to provide 100 percent coverage of the survey area at sufficient density to detect all detectable MEC items. The measurement performance criterion for this is that the lane spacing varies no more than ±20 percent of spacing specified in the sampling design. This will be evaluated during the GPO by verifying that all of the DGM data collected and used for anomaly selection meets this standard.

### 2.2.4 Positioning Accuracy

The DQO for horizontal positioning accuracy is that positioning of detected anomalies is accurate enough to allow for effective reacquisition of the anomaly. The measurement performance criterion for this is that 95 percent of all anomaly locations (as shown on the dig sheets) lie within a 1-meter radius of a point on the ground surface directly above the source of the anomaly. Any anomaly that is selected (coordinates shown on the dig sheets) outside of 1 meter from a point directly above the item will not be considered to be a detection of that item. This will be evaluated during the GPO by verifying that all anomalies selected are within this standard or can be otherwise explained.

## 2.3 Data Handling

The DQO for data handling is that all data must be delivered in a timely manner and in a useable format. Because of the need for rapid feedback during GPO operations to effectively test potential DGM systems, the measurement performance criterion for data handling during GPO activities will require that data packages (see Section 8) be completed and delivered to the CH2M HILL Project Geophysicist **within 1 working day of data collection**. During production surveys, the measurement performance criterion for data handling will require that "draft" (raw) data packages be completed and delivered to the CH2M HILL Project Geophysicist within 3 working days of data collection and the final data packages within 5 working days of data collection. This will be evaluated based on the actual delivery of data during the GPO.

# 3.0 Personnel and Qualifications

All personnel involved in performance of the GPO and the production geophysical surveys will meet the following qualifications:

- **Project Geophysicist:** will have a degree in geophysics, geology, geological engineering, or a closely related field, and have a minimum of 7 years of directly related geophysical experience. This individual will be capable of managing a geophysical data collection and processing project/program including several task orders/sites.
- **Site Geophysicist:** will have a degree in geophysics, geology, geological engineering, or a closely related field, and have a minimum of 5 years of directly related geophysical experience. This individual will be capable of competently managing personnel,

equipment and data on projects requiring multiple (three or more) geophysical field teams and geophysical data processors.

- **Geophysical Data Processor:** will have a degree in geophysics, geology, geological engineering, or a closely related field, and will have at least 6 months experience in processing geophysical data related to MEC projects.
- **Field Geophysicist:** will have a degree in geophysics, geology, geological engineering, or a closely related field, and will have a minimum of 2 years of directly related geophysical experience related to MEC projects.
- **Geophysical Technician:** will have at least 6 months of experience in geophysical data collection on MEC related projects.

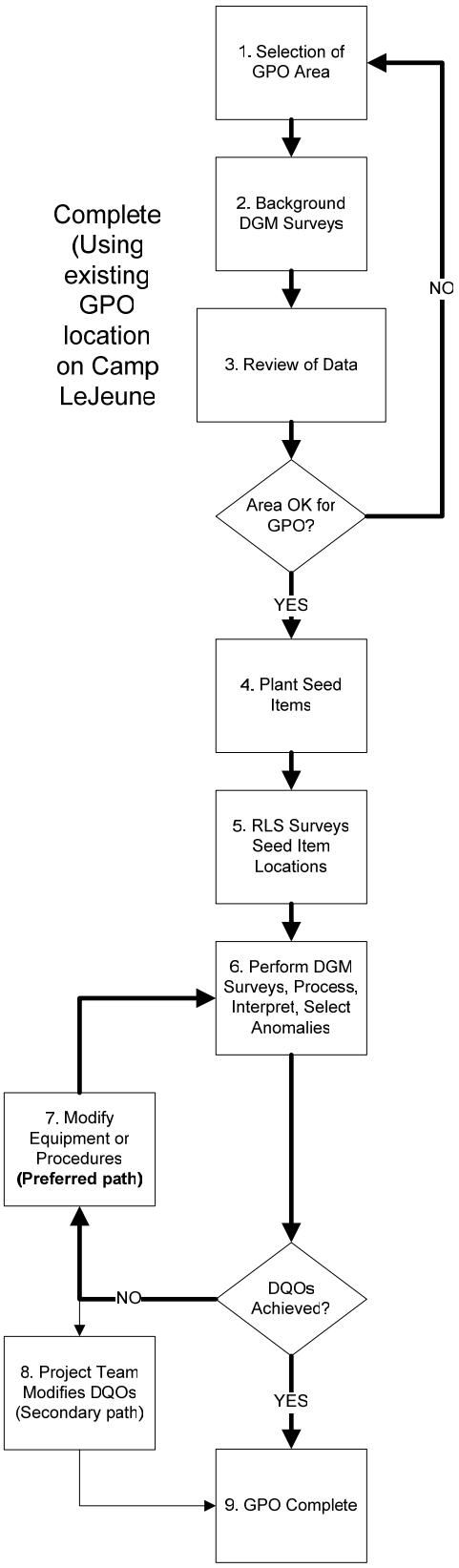
The following CH2M HILL team individuals will be involved.

- CH2M HILL Project Geophysicist
- UXO Technician II (or higher)
- DGM subcontractor's Site Geophysicist
- DGM subcontractor's Data Processor(s)
- DGM subcontractor's Geophysical Technician(s)

# 4.0 Procedures

A qualified and experienced MEC DGM operations geophysical team (see Section 3.0) will separately employ each system to be tested on the GPO plot. Figure 1 illustrates the GPO process and the procedures to be employed (numbered in accordance with the steps shown on Figure 1) during site work.

FIGURE 1
GPO Process



1. A GPO area will be selected based on:

    (a) Terrain, geology and vegetation similar to that of the project site.

    (b) Geophysical noise conditions similar to those expected across the survey area.

    (c) Large enough site to accommodate all necessary GPO tests and equipment and for adequate spacing of the seed items to avoid ambiguities in data evaluation.

    (d) Readily accessible to project personnel.

    (e) Close proximity to the actual survey site.

2. A "background" DGM survey will be performed by the DGM subcontractor with the instrument to be tested in the GPO. This step will allow background geophysical conditions to be recorded, will help determine the appropriateness of the location (i.e., few existing anomalies), and will verify that items are not seeded near existing anomalies. The data will be post-processed (i.e., filtered and positions attached to the geophysical data) but the DGM subcontractor will not view the results apart from this.

3. The data will be provided to the CH2M HILL Project Geophysicist for evaluation.

4. A sufficient number of seed items will be buried at a range of depths and orientations to document detection limits within the GPO grid. The targets will include simulated items intended to represent MK-II hand grenades.

    CH2M HILL personnel will construct the GPO using shovels and, if necessary, a mechanical auger or backhoe to dig the holes to the appropriate depths for burial of the seed items. The seed items will be painted blue and tagged with a non-biodegradable label identifying the items as inert and providing a contract reference, a point of contact address, phone number, and a target identifier. The background survey data and anomaly avoidance techniques will be used to ensure that corner stakes and seed items are not placed on top of or near existing anomalies. Personnel will emplace each seed item and record the emplacement data (depth, orientation, and azimuth). All seed items will be photographed prior to burial.

5. A Registered Land Surveyor (RLS) will use a Real-Time Kinematic (RTK) Differential Global Positioning System (DGPS) or conventional Total Station survey equipment to record seed item locations to a horizontal accuracy of 3 centimeters (cm) and a vertical accuracy of 5 cm, providing an Easting and Northing (in NAD83 UTM 16N, meters) for the center and each end (where applicable) of the targets. The location of the four corners of the grid will also be recorded (in UTM meters). All target markings in the GPO grid will be removed and the grid will be returned as near as possible to its natural condition. Information on the seeded target's location will not be released to the DGM subcontractor.

6. DGM surveys will be performed by the DGM subcontractor using an EM61-MK2 time domain metal detector system. The system configurations to be tested are shown in Table 3. The data will be processed and interpreted by the DGM subcontractor and anomaly selections made. "Draft-Final" data packages will be provided to the CH2M HILL Project Geophysicist for evaluation.

7. If the initial DQOs have not been met, the CH2M HILL Project Geophysicist will meet with the DGM subcontractor to discuss whether modifications (e.g., sensor spacing) or procedures (e.g., lane spacing) can be made to the DGM system in order to meet the DQOs.
8. If the DQOs cannot be met by the DGM subcontractor, the CH2M HILL Project Geophysicist will meet with the NAVFAC LANTDIV Project Manager to discuss a resolution (i.e., modification of a DQO) prior to completing the GPO.
9. Once the surveys have been performed and at least one of the configurations has been determined capable of meeting the initial (or modified) DQOs, the GPO will be complete.

TABLE 2
Evaluation Chart

| Criteria | System | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| P%[1] | | | | | | |
| P% (items within typical detection depths equation[2]) | | | | | | |
| P% – MK-II Simulant Seed Items | | | | | | |
| P% – MK-II Simulant Seed Items (items within typical detection depths equation[2]) | | | | | | |
| Number of false positives | | | | | | |
| False Anomaly Rate[4] | | | | | | |
| Downline Data Density DQO Met? (Y/N) | | | | | | |
| Survey Coverage (Lane Spacing) DQO Met? (Y/N) | | | | | | |
| DGM Positioning Accuracy DQO Met? (Y/N) | | | | | | |
| Average positioning error on initial anomaly selection (meters) | | | | | | |
| Data Handling DQO Met? (Y/N) | | | | | | |
| Maximum depth MK-II Simulant Seed Items detected[3] at all orientations | | | | | | |

[1]P% = Percent Detected (anomaly selected within 1.0m of point at surface above seed item)
[2]USACE (USACE DID MR-005-05.01): Estimated Depth (meters) = 11*diameter (mm)/1000
[3]Anomaly selected within 1.0 m of point at surface above seed item.
[4]Number of false positives per detected item.

TABLE 3
Geophysical Equipment Tests to be Performed during GPO

| Test | Instrument | Positioning System | Approximate Sensor Height Above Ground Surface (ft) | Lane Width (ft) | Data Collection Rate (per second) | Approximate Survey Speed (ft/s) |
|---|---|---|---|---|---|---|
| 1 | EM61-MK2 Single Coil | RTK GPS | 1.35 | 2.5 | 10 | 3 |
| 2 | EM61-MK2 Single Coil | TBD* | 1.35 | 2.5 | 10 | 3 |
| 3 | EM61-MK2 Array | RTK GPS | TBD* | TBD* | TBD* | TBD* |
| 4 | EM61-MK2 Array | TBD* | TBD* | TBD* | TBD* | TBD* |

Note that some of the data elements are subject to modification and evaluation in the field.

*Based on proposals from DGM subcontractor. (To be updated prior to final Work Plan submittal.)

# 5.0 Additional GPO Considerations

Additional topics taken into consideration for the design of the GPO include plot location, size, and shape; quantities of seeded items; and geophysical and positioning instruments and technologies.

## 5.1 GPO Plot Location

The location of the GPO will be determined on the basis of field conditions at the time the GPO is conducted. The plot will be located in an area where the geology, vegetation, and terrain area as similar as possible to the actual site conditions. Consideration will also be given to locating the GPO plot in an area with the least amount of metallic debris on the surface and in the subsurface.

## 5.2 GPO Size and Shape

The intended dimensions of the GPO plot are 100 ft x 100 ft.

## 5.3 Number and Types of Geophysical Instruments and Technologies Selected for Testing

Because of the type of targets to be detected at the site, a pre-field analysis of the two primary techniques used in the industry, magnetics and time domain electromagnetics (TDEM), CH2M HILL recommends testing of the TDEM technique only. This recommendation is based on experience at multiple other sites at which the small and shallow items have consistently been detected at a higher rate with TDEM than with magnetics. The geology at the site is not anticipated to be advantageous to either system.

A complete description of the EM61 is provided in the instrument-specific Standard Operating Procedures (SOPs) to be provided by the geophysical services subcontractor.

## 5.4 Number and Types of Positioning Instruments and Technologies Selected for Testing

Both sub-centimeter GPS and Robotic Total Station (RTS) systems will be tested for positioning of the geophysical data. Although it is understood that some degree of tree and other vegetation removal will take place prior to performing the geophysical surveys at the site, if there are still trees remaining then CH2M HILL may need to use the RTS for some of the surveys because of inadequate satellite availability through the trees.

# 6.0 Quality Control

All systems will be field tested by the DGM subcontractor to ensure that they are operating properly. Several basic quality control (QC) tests will be performed in addition to instrument specific tests. The instrument specific tests are described in the instrument operation SOPs that will be provided by the geophysical services subcontractor. A description of each basic QC test, its acceptance criteria and test frequency is provided below and summarized in Table 4.

1. **Equipment Warm-up**. This is an instrument specific activity (although standard warm-up time is 5 minutes). Some geophysical systems require more warm-up time than others. Each system specific SOP (attached in Attachment A) defines the equipment-specific warm-up time. Equipment warm-up will be performed each time the instrument is first turned on for the day or has been turned off for a sufficient amount of time for the specific instrument to cool down.
2. **Record Sensor Positions**. Positioning accuracy of the final processed data will be demonstrated by operating the equipment over one or more known points. It is important that the positioning system be tested in exactly the same manner in which it is to be used during the actual surveys. The accuracy of the data positioning will be assessed by calculating the difference between the location where the track-plots cross each other on the map and the actual location of the known point(s). Presumably, the actual track-plots will cross exactly over the known point when the data was collected, and the difference, if any, observed on the final track-plot map is a direct measure of the positioning system's accuracy. The sensor position test will be conducted at the beginning of the survey operations for each work day.
3. **Personnel Test.** This test checks the response of instruments to the personnel and their clothing and proximity to the system. On a daily basis, instrument coils/sensors (for those instruments being used that day) will be checked for their response to the personnel operating the system. The response will be observed in the field for immediate corrective action and transmitted back to the processor, and analyzed and checked for spikes in the data that can possibly create false anomalies. The personnel test will be conducted at the beginning of the survey operations for each work day.

TABLE 4
Geophysical Instrument Standardization Tests and Acceptance Criteria

| Test | Test Description | Acceptance Criteria | Power on | Beginning of day | Beginning and end of day | 1st time instrument used | 2% of Total Area Surveyed |
|---|---|---|---|---|---|---|---|
| 1 | Equipment Warm-up | Equipment specific (typically 5 min) | X | | | | |
| 2 | Record Sensor Positions | +/- 4 inch (2.54 cm) | | X | | | |
| 3 | Personnel Test | Based on instrument used. Personnel, clothing, etc. should have no effect on instrument response. | | X | | | |
| 4 | Vibration Test (Cable Shake) | Data profile does not exhibit data spikes | | X | | | |
| 5 | Static Background & Static Spike | +/- 20% of standard item response, after background correction | | | X | | |
| 6 | Six Line Test | Repeatability of response amplitude +/-20%, Positional Accuracy +/- 20 cm | | | | X | |
| 7 | Repeat Data | Repeatability of response amplitude +/-20%, Positional Accuracy +/- 20 cm | | | | | X |

* Magnetometer Only

4. **Vibration Test (Cable Shake).** This test checks the response of instruments to vibration. On a daily basis, instrument coils/sensors (for those instruments being used that day) will be checked for their response to vibrations in the cables. The response will be observed in the field for immediate corrective action and transmitted back to the processor and analyzed and checked for spikes in the data that can possibly create false anomalies. The vibration test will be conducted at the beginning of the survey operations for each work day.

5. **Static Background and Static Spike**. Static tests will be performed by positioning the survey equipment within or near the survey boundaries in an area free of metallic contacts, and collecting data for a minimum period of three minutes. During this time, the instrument will be held in a fixed position without a spike (known standard) and then with a spike. The purpose of the static test is to determine whether unusual levels of instrument or ambient noise exist. The static background and static spike test will be conducted at the beginning and end of each survey operation.

6. **Six Line Test.** The Six Line test is a standard response test consisting of a predetermined route (survey line) established on or near the site in an area free of metallic contacts. The beginning, midpoint, and end of the line will be marked, and data will be collected along the line. The line will be traversed a total of six times as follows: 1) *normal* data collection speed *without* a spike at the centerpoint; 2) *normal* data collection speed *without* a spike at the centerpoint; 3) *normal* data collection speed *with* a spike at the centerpoint; 4) *normal* data collection speed *with* a spike at the centerpoint; 5) *fast* data collection speed *with* a spike at the centerpoint; 6) *slow* data collection speed *with* a "pike at the centerpoint. (Speed of data collection will also be evaluated as part of the GPO evaluation process.) The Six Line test will be conducted the first time a system is used at the site.
7. **Repeat Data.** This test is performed to ensure repeatability of the data and will be performed after the initial survey over an area.

# 7.0 Records Management

All raw data files, final processed data files, hard copies, and field notes will be maintained by the DGM subcontractor for the duration of the GPO and then turned over to the CH2M HILL Project Geophysicist.

# 8.0 Data Delivery

The DGM data delivery requirements include the following:

- All sensor data will be correlated with navigational data based upon a local "third order" (1:5,000) monument or survey marker. If a suitable point is not available, CH2M HILL will have a professional land surveyor establish a point.
- All sensor data will be preprocessed for sensor offsets, diurnal magnetic variations, latency corrections, drift corrections, etc., and correlated with navigation data.
- Diurnal magnetic variations measured at a base-station must be collected at a minimum of once per minute.
- The DGM system will digitally capture the instrument readings into a file coincident with the grid coordinates.
- All raw and final processed data will be delivered corrected and processed in ASCII files.
- Corrections such as for navigation, instrument bias, and diurnal magnetic shift will be applied.
- All corrections will be documented (see Table 5).
- Data will be presented in delineated fields as x, y, z, v1, v2, etc., where x and y are NAD83 UTM Grid Plane Coordinates in Easting (meters) and Northing (meters) directions, z (elevation is an optional field in meters), and v1, v2, v3, etc., are the instrument readings.

- The last data field should be a time stamp.
- Each data field will be separated by a comma or tab.
- No individual file may be more than 100 megabytes (Mb) in size and no more than 600,000 lines long.
- Each grid (or set) of data will be logically and sequentially named so that the file name can easily be correlated with the grid name used by other project personnel.
- Within one working day after collection, the DGM subcontractor will furnish draft-final data packages for each system's survey via internet using FTP, E-mail attachment for small files under 5 Mb, CD-ROM, or other approved method. Final data packages must include the following:
  - Dig sheets (anomaly selections) in Microsoft Excel formats
  - PDF file(s) of color contoured geophysical results with anomaly selections shown and labeled at a readable scale
  - Geosoft format GDB files and packed maps
  - Raw data files
  - Final processed data files
  - All quality control data files associated with the survey files
  - Microsoft Word 6.0 or higher file documenting the field activities associated with the data, and the processing performed (see Table 5)
  - Digital planimetric map, in Geosoft and ArcView format, and coincident with the location of the geophysical survey

TABLE 5
Processing Documentation Requirements

| Information Type | Final Data Delivery | Must be in File Headers |
|---|---|---|
| Site ID | X | X |
| Geophysical instrument type used | X | X |
| Positioning method used | X | X |
| Instrument serial numbers (geophysical and positioning) | X | |
| Coordinate system and unit of measure | X | X |
| Grid ID (or other identifier of surveyed area) | X | X |
| Date of data collection | X | X |
| Raw data file names associated with delivery | X | X |
| Processed data file names associated with delivery | X | X |
| Name of Project Geophysicist | X | |
| Name of Site Geophysicist | X | |
| Name of data processor | X | X |
| Data processing software used | X | |
| Despiking method and details | X | |
| Sensor drift removal and details | X | |
| Latency correction and details | X | |
| Heading correction and details | X | |
| Sensor bias, background leveling and/or standardization adjustment method and details | X | |
| Diurnal correction (magnetic data) | X | |
| Geophysical noise identification and removal (spatial, temporal, motional, terrain induced) and details | X | |
| Other filtering/processing performed and details | X | |
| Gridding method | X | |
| Anomaly selection and decision criteria details | X | |
| Other processing comments | X | |
| Date data processing is completed | X | |
| Data delivery date | X | |
| Scanned copy of field notes and field PDA notes (if applicable) | X | |

# 9.0 Reporting

CH2M HILL will prepare a GPO Report that will include the following elements:

- As-built drawing of the GPO plot
- Pictures of the seed items
- Color maps of the geophysical data
- Summary of the GPO results
- Geophysical equipment, techniques, and methodologies selected for the production survey
- Sufficient supporting information to justify selection

**APPENDIX A**

# DGM Subcontractor Standard Operating Procedures

| DGM Subcontractor SOP No | Version | Title |
|---|---|---|
| | | |
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# Appendix D
# Standard Operating Procedures

**STANDARD OPERATING PROCEDURE A-1**

# Shallow Soil Sampling

## I. Purpose

To provide general guidelines for the collection and handling of surface soil samples during field operations.

## II. Scope

The method described for surface soil sampling is applicable for loosely packed earth and is used to collect disturbed-soil samples.

## III. Equipment and Materials

- Sample jars.
- A hand auger or other device that can be used to remove the soil from the ground. Only stainless steel, Teflon, or glass materials should be used. The only exception is split spoons, which are most commonly available in carbon steel; these are acceptable for use only if they are not rusty.
- A stainless steel spatula should be used to remove material from the sampling device.
- Unpainted wooden stakes or pin flags
- Fiberglass measuring tape (at least 200 feet in length)

## IV. Procedures and Guidelines

A. Wear protective gear, as specified in the Health and Safety Plan.

B. To locate samples, identify the correct location using the pin flags or stakes. Proceed to collect a sample from the undisturbed soil adjacent to the marker following steps C and D. If markers are not present, the following procedures will be used.

1. For samples on a grid:

a. Use measuring tape to locate each sampling point on the first grid line as prescribed in the sampling plan. As each point is located, drive a numbered stake in the ground and record its location on the site map and in the logbook.

b. Proceed to sample the points on the grid line.

**STANDARD OPERATING PROCEDURE A-2**

# Surface Soil Sampling

## I. Purpose and Scope

The purpose of this procedure is to provide guidelines for obtaining samples of surface soils for laboratory analysis. Soil samples for VOC analysis using the EnCore® sampler should be collected using the procedures in SOP A-3.

## II. Equipment and Materials

All or some of the following items will be required, depending on the types of soil samples being collected and the methods being used. Refer to Paragraph III, below.

- Stainless-steel trowel, shovel, scoopula, coring device, trier, hand auger, or other appropriate hand tool
- Stainless-steel, split-spoon samplers
- Thin-walled sampling tubes
- Drilling rig or soil-coring rig
- Stainless-steel pan or bowl
- Sample bottles

## III. Procedures and Guidelines

Before sampling begins, equipment will be decontaminated using the procedures described in the appropriate SOP for equipment decontamination, unless pre-cleaned equipment is being used (i.e., single use disposable sampling accessories). The sampling point is located and recorded in the field logbook. Debris should be cleared from the sampling location.

### A. Surface and Shallow Subsurface Sampling

A shovel, post-hole digger, or other tool can be used to remove soil to a point just above the interval to be sampled. A decontaminated sampling tool will be used to collect the sample when the desired sampling depth has been reached. Soil for semivolatile organic and inorganic analyses is placed in the bowl and mixed. Soil for volatile organic analysis is not mixed or composited but is placed directly into the appropriate sample bottles. (NOTE: If EnCore® samplers are being used, refer to SOP A-2, *Soil Sampling for VOCs Using the Encore Sampler*.) A stainless-steel or dedicated wooden tongue depressor is used to transfer the sample from the bowl to the container.

The soils removed from the borehole should be visually described in the field log book, including approximated depths.

When sampling is completed, photo-ionization device (PID) readings should be taken directly above the hole, and the hole is then backfilled.

More details are provided in the SOP *Shallow Soil Sampling.*

## B. Split-Spoon Sampling

Using a drilling rig, a hole is advanced to the desired depth. For split-spoon sampling, the samples are then collected following the ASTM D 1586 standard (attached). The sampler is lowered into the hole and driven to a depth equal to the total length of the sampler; typically this is 24 inches. The sampler is driven in 6-inch increments using a 140-pound weight (``hammer'') dropped from a height of 30 inches. The number of hammer blows for each 6-inch interval is counted and recorded. To obtain enough volume of sample for subsequent laboratory analysis, use of a 3-inch ID sampler may be required. Blow counts obtained with a 3-inch ID spoon would not conform to ASTM D 1586 and would therefore not be used for geotechnical evaluations.

Once retrieved from the hole, the sampler is carefully split open. Care should be taken not to allow material in the sampler to fall out of the open end of the sampler. To collect the sample, the surface of the sample should be removed with a clean tool and disposed of. Samples collected for volatiles analysis should be placed directly into the sample containers from the desired depth in the split spoon. Material for samples for all other parameters should be removed to a decontaminated stainless steel tray. The sample for semivolatile organic and inorganic analyses should be homogenized in the field by breaking the sample into small pieces and removing gravel. The homogenized sample should be placed in the sample containers. If sample volume requirements are not met by a single sample collection, additional sample volume may be obtained by collecting a sample from below the sample and compositing the sample for non-volatile parameters only.

Split-spoon samples also will be collected using a tripod rig. When using a tripod rig the soil samples are collected using an assembly similar to that used by the drilling rig.

## C. Thin-Walled Tube Sampling

Undisturbed samples may be collected for analysis for geotechnical parameters such as vertical hydraulic conductivity. These samples will be collected using thin-walled sampling tubes (sometimes called Shelby tubes) according to ASTM D 1587 (attached). Tubes will be 24- to 36 inches long and 3- to 4-inches in diameter, depending upon the quantity of sample required. Undisturbed samples will be obtained by smoothly pressing the sampling tube through the interval to be sampled using the weight of the drilling rig. Jerking the sample should be avoided. Once the sample is brought to the surface, the ends will be sealed with bees wax and then sealed with end caps and heavy tape. The

sample designation, data and time of sampling, and the up direction will be noted on the sampling tube. The tube shall be kept upright as much as possible and will be protected from freezing, which could disrupt the undisturbed nature of the sample. Samples for analysis normally are not collected from thin-walled tube samples.

# IV. Attachments

ASTM D 1586 *Standard Penetration Test Method for Penetration Test and Split-Barrel Sampling of Soils*

ASTM D 1587 *Standard Practice for Thin-Walled Tube Sampling of Soils*

# V. Key Checks and Preventative Maintenance

- Check that decontamination of equipment is thorough.
- Check that sample collection is swift to avoid loss of volatile organics during sampling.

**STANDARD OPERATING PROCEDURE A-3**

# Soil Sampling for VOCs Using the EnCore® Sampler

## I. Purpose and Scope

The purpose of this procedure is to provide guidelines for obtaining samples of surface and subsurface soils using the EnCore® Sampler.

## II. Equipment and Materials

- The EnCore® Sampler 5g or 25g versions
- Reusable T-handle with a plunger
- 40 mL VOA vial
- 2 oz wide mouth jar

## III. Procedures and Guidelines

The sampling point is located and recorded in the field logbook. Debris should be cleared from the sampling location. The EnCore® sampler is being used to collect, store and deliver soil in a sealed, headspace-free state.

### A. Surface and Shallow Subsurface Sampling

A shovel, post-hole digger, or other tool can be used to remove soil to a point just above the interval to be sampled. Remove EnCore® sampler from package and attach handle. Quickly collect a 5 or 25 gram sample using the EnCore® sampler. Attach the cap. Fill out a label and attach to sampler.

Ship one EnCore® Sampler per sample location. If low-level analyses are needed, two additional EnCore® samplers will be required. T**he EnCore® sampler has to reach the lab for preservation within 48 hours.** Please refer to the SOP *Packaging and Shipping Procedures* for guidance on shipping.

The soils removed from the borehole should be visually described in the field log book, including approximated depths.

When sampling is completed, photo-ionization device (PID) readings should be taken directly above the hole, and the hole is then backfilled.

### B. Split-Spoon Sampling

Using a drilling rig, a hole is advanced to the desired depth. For split-spoon

sampling, the samples are then collected following the ASTM D 1586 standard (see SOPs for *Soil Boring Drilling and Abandonment* or *Logging of Aoil Borings* for this ASTM). The sampler is lowered into the hole and driven to a depth equal to the total length of the sampler; typically this is 24 inches. The sampler is driven in 6-inch increments using a 140-pound weight (``hammer'') dropped from a height of 30 inches. The number of hammer blows for each 6-inch interval is counted and recorded. To obtain enough volume of sample for subsequent laboratory analysis, use of a 3-inch ID sampler may be required. Blow counts obtained with a 3-inch ID spoon would not conform to ASTM D 1586 and would therefore not be used for geotechnical evaluations.

Once retrieved from the hole, the sampler is carefully split open. Care should be taken not to allow material in the sampler to fall out of the open end of the sampler. To collect the sample, the surface of the sample should be removed with an empty EnCore® Sampler. Samples collected for volatiles analysis should be placed directly into the sample containers from the desired depth in the split spoon.

Split-spoon samples also will be collected using a tripod rig. When using a tripod rig the soil samples are collected using an assembly similar to that used by the drilling rig.

## IV. Attachments

None

## V. Key Checks and Preventative Maintenance

Check that sample collection is swift to avoid loss of volatile organics during sampling.

**STANDARD OPERATING PROCEDURE A-4**

# Homogenization of Soil and Sediment Samples

## I. Purpose

The homogenization of soil and sediment samples is performed to minimize any bias of sample representativeness introduced by the natural stratification of constituents within the sample.

## II. Scope

Standard techniques for soil and sediment homogenization and equipment are provided in this SOP. These procedures do not apply to aliquots collected for VOCs or field GC screening; samples for these analyses should NOT be homogenized.

## III. Equipment and Materials

Sample containers, stainless steel spoons or spatulas, and stainless steel pans.

## IV. Procedures and Guidelines

Soil and sediment samples to be analyzed for explosives residues, semivolatiles, pesticides, PCBs, metals, cyanide, or field XRF screening should be homogenized in the field. After a sample is taken, a stainless steel spatula should be used to remove the sample from the split spoon or other sampling device. The sampler should not use fingers to do this, as gloves may introduce organic interferences into the sample.

If samples for VOCs are collected, they should be taken immediately upon opening the spoon and should not be homogenized.

Prior to homogenizing the soil or sediment sample, any rocks, twigs, leaves, or other debris should be removed from the sample. The sample should be placed in a decontaminated stainless steel pan and thoroughly mixed using a stainless steel spoon. The soil or sediment material in the pan should be scraped from the sides, corners, and bottom, rolled into the middle of the pan, and initially mixed. The sample should then be quartered and moved to the four corners of the pan. Each quarter of the sample should be mixed individually, and then rolled to the center of the pan and mixed with the entire sample again.

All stainless steel spoons, spatulas, and pans must be decontaminated following procedures specified in the appropriate SOP prior to homogenizing the sample. A composite equipment rinse blank of homogenization equipment should be taken each day it is used.

## V. Attachments

None.

## VI. Key Checks and Items

- Take VOC samples immediately and do not homogenize the soil.
- Homogenize soil for analyses other than VOCs in a clean, stainless steel bowl.

c. Measure to location where next grid line is to start and stake first sample. For subsequent samples on the line take two orthogonal measurements: one to the previous grid line, and one to the previous sample on the same grid line.

d. Proceed to sample the points on the grid line as described in Section C below.

e. Repeat 1c and 1d above until all samples are collected from the area.

2. For non-grid samples:

a. Use steel measuring tape to position sampling point at location described in the sampling plan by taking two measurements from fixed landmarks (e.g., corner of house and fence post).

b. Note measurements, landmarks, and sampling point on a sketch in the field notebook, and on a site location map.

c. Proceed to sample as described in Section C below.

d. Repeat 2a through 2c above until all samples are collected from the area.

C. To the extent possible, differentiate between fill and natural soil. If both are encountered at a boring location, sample both as prescribed in the field sampling plan. Do not locate samples in debris, tree roots, or standing water. In residential areas, do not sample in areas where residents' activities may impact the sample (e.g., barbecue areas, beneath eaves of roofs, driveways, garbage areas). If an obstacle prevents sampling at a measured grid point, move as close as possible, but up to a distance of one half the grid spacing in any direction to locate an appropriate sample. If an appropriate location cannot be found, consult with the Field Team Supervisor (FTS). If the FTS concurs, the sampling point will be deleted from the program. The FTS will contact the CH2M HILL project manager (PM) immediately. The PM and Navy Technical Representative (NTR) will discuss whether the point should be deleted from the program. If it is deleted, the PM will follow-up with the NTR in writing.

D. To collect samples:

1. Use a decontaminated stainless steel scoop/trowel to scrape away surficial organic material (grass, leaves, etc.) adjacent to the stake. New disposable scoops or trowels may also be used to reduce the need for equipment blanks.

2. If sampling:

a. Surface soil: Obtain soil sample by scooping soil using the augering scoop/trowel, starting from the surface and digging

down to a depth of about 6 inches, or the depth specified in the workplan.

b. Subsurface soil: Obtain the subsurface soil sample using an auger down to the depths prescribed in the field sampling plan.

3. Take a photoionizaton detector (PID) reading of the sampled soil and record the response in the field notebook. Also record lithologic description and any pertinent observations (such as discoloration) in the logbook.

4. Empty the contents of the scoop/trowel into a decontaminated stainless steel pan.

5. Repeat this procedure until sufficient soil is collected to meet volume requirements.

6. For TCL VOC and field GC aliquots, fill sample jars directly with the trowel/scoop and cap immediately upon filling. DO NOT HOMOGENIZE.

7. For TCL pesticides/PCBs and SVOCs, TAL metals, and field XRF aliquots, homogenize cuttings in the pan using a decontaminated stainless steel utensil in accordance with SOP *Decontamination of Drilling Rigs and Equipment*.

8. Transfer sample for analysis into appropriate containers with a decontaminated utensil.

9. Backfill the hole with soil removed from the borehole. To the extent possible, replace topsoil and grass and attempt to return appearance of sampling area to its pre-sampled condition. For samples in non-residential, unmowed areas, mark the sample number on the stake and leave stake in place. In mowed areas, remove stake.

# V. Attachments

None.

# VI. Key Checks and Items

- Use phthalate-free latex or surgical gloves and other personal protective equipment.
- Transfer volatiles first, avoid mixing.
- Decontaminate utensils before reuse, or use dedicated, disposable utensils.